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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to an organic electroluminescence (it is written also as organic electroluminescence below) element excellent in luminous efficiency and a manufacturing method for the same, the display that has it, a lighting system, and a light source.

[0002]

[Description of the Prior Art]

An organic EL device is a current drive type light emitting device which emits light by sending current on both sides of a very thin thin film by the anode and the negative pole.

[0003]

Usually, although an organic matter is an insulator, by making thickness of an organic layer very thin, the current injection of it becomes possible and the drive of it as organic electroluminescence is attained. Since it is actually possible to drive by the low voltage not more than 10V and it is possible to obtain efficient luminescence, it is observed as a future display.

[0004]

the phosphorescence emitting system organic EL device endured you to be Haruka is found out by S.R.Forrest etc. in the efficiency of the organic electroluminescence of especially the former in these days (Appl.Phys.Lett. (1999).) As C.Adachi etc. have reported to 75 (1), 4-6, and a pan, It has come to take out the luminous efficiency which also attains to 60 (J. Appl.Phys., 90, 5048 (2001)) lm/W with optimizing the material to be used, and, as for the application to an electronic display, the application to lighting is also expected with last thing.

[0005]

Generally, an organic EL device is divided into two, a low molecule system and a polymers

system.

The low molecular weight compound as a feature in which it is common to the organic compound layer of an organic EL device and manufacture of an electrode using vacuum deposition as for a low molecule system, and high grade refining is easy can be used as an organic electroluminescence material, Since it is easy to make a laminated structure furthermore, it excels in the field of efficiency and a life dramatically. However, in order to vapor-deposit under the high vacuum conditions below of  $10^{-4}$  Pa, an improvement is desired, and especially when [ especially ] applying to the electronic display of a lighting use or a large area, it becomes a problem from a viewpoint of manufacture. It is difficult to vapor-deposit a phosphorescence dopant which is used with a phosphorescence emitting system organic EL device uniform with a large area, and to form a film, and when making especially white profitably like, since two or more dopants will be simultaneously doped in a film with vacuum deposition, principle top difficulty is high [ a thing ].

[0006]

The polymers system can manufacture the organic compound layer of an organic EL device by spreading processes, such as a spin coat, an ink jet, printing, and a spray, to it. When producing the organic layer of an organic EL device while low-cost-izing is possible, since this can be manufactured with atmospheric pressure, Solution preparation of the required material (a polymer material and/or low molecule material) is carried out, and in order to carry out thin film spreading, it is easy to carry out preparation of the dopant to a luminescence host material, etc., there is the feature that nonuniformity is not easily made to a large area, and it is dramatically advantageous also in respect of a manufacturing cost.

[0007]

However, in said phosphorescence emitting system organic EL device, When an organic layer was produced in such a spreading process, compared with the organic EL device produced by said J.Appl.Phys. and a low molecule vacuum evaporation system which is indicated to 90 and 5048 (2001), luminous efficiency was substantially inferior, and there was a problem that the predominance of phosphorescence luminescence will be lost. For example, the organic EL device which mixed the alt.metal-ized complex of Ir content which is the polyvinyl carbazole and phosphorescence dopant which are indicated to JP,2001-257076,A, and was produced with the spin coat method is obtained only the luminous efficiency about the half of said low molecule vacuum evaporation system organic EL device.

[0008]

Although phosphorescence luminescence is attained to the patent documents 1 as similar composition in the combination of polymer and the phosphorescence dopant which are compounded from the monomer to which the vinyl group was introduced into the benzene ring portion of the carbazole skeleton, Illustration of green emission is only specifically indicated

and the above and a big difference are not accepted fundamentally. Although the patent documents 1 have the illustration (the 12th page, H-27) of a copolymer with N-methyl-4-vinylcarbazole and 4-vinyltriphenylamine, The performance of the polymer which the example which combined this compound with the phosphorescence dopant was not indicated, either, but carried out copolymerization of two sorts of monomers is unknown.

[0009]

A polyvinyl carbazole will be made the 8th volume, the September item, and the 47-51st page (Techno Times company issue) with a luminescence host in a similar manner in a monthly display magazine and 2002, Mixed the blue phosphorescence dopant and the red phosphorescence dopant, and white light is realized by adding a low molecule electron transport material further, Although the improvement was accepted compared with the conventional firefly luminescence system as a white light organic EL device, the luminous efficiency was about 1/4 of the theoretical limit of an original phosphorescence emitting system, and was not enough satisfactory. This greatest reason is considered because it is in a difficult thing and the packing state of the low molecule material (a luminescence dopant or an electron transport material) distributed in the polymer material (luminescence host) to constitute the laminated structure of three or more layers from a polymers system probably. When a polymers system laminates a bilayer eye on eyes further for wet process, the polymers (it is also henceforth called polymer) of eyes melt into the solvent of a bilayer eye further, and it is expected that performance deteriorates because both mix by the interface of eyes and a bilayer eye further.

[0010]

Polymers much more meltable [ as a method of improving the above-mentioned problem in a polymers system ] to a drainage system solvent in eyes, the polymers system organic EL device of two-layer lamination comprises using polymers meltable to an organic solvent for a bilayer eye -- \*\*\*\* (for example, refer to patent documents 2) -- most polymers organic EL devices made into the laminated structure of three or more layers which carried out multilayer lamination of the polymers meltable to an organic solvent are not reported.

[0011]

In said monthly display magazine and 2002 also to the 8th volume, the September item, and the 47-51st page (Techno Times company issue). Although the polymers organic EL device which paints a water soluble hole injection layer on the 1st layer similarly, paints what melted luminescence host polymer, the low-molecular phosphorescence dopant, and the further low-molecular electron transport material in the organic solvent at the 2nd layer, and emits the phosphorescence of a two-layer system is produced, Satisfying luminous efficiency is not acquired as above-mentioned.

[0012]

the organic layer of the polymers organic EL device of such a two-layer system -- further -- an organic solvent -- piling up a meltable organic layer, although a principle top is possible by choosing the polymer material and solvent which are used, for example, The high throughput which is the greatest advantage of a polymers system is sacrificed for the film production process of repeating spreading-desiccation two or more times.

A manufacturing method of the organic EL device with which high luminous efficiency is acquired by the smallest possible number of times of spreading is desired.

[0013]

A polymer material which can attain luminous efficiency and a life equivalent to multilayer low molecule system organic electroluminescence only by applying is also desired.

[0014]

As for a host, when using a phosphorescent compound as a dopant, it is needless to say that it is more nearly required for a short wave field than the phosphorescence luminescence maximum wavelength of a phosphorescent compound to have a phosphorescence luminescence maximum wavelength, but it has turned out that there are conditions which should be fulfilled.

[0015]

In The 10 th International Workshop on Inorganic and Organic Electroluminescence (EL'00, Hamamatsu), some reports are made about the phosphorescent compound. For example, Ikai uses the compound of hole transportability as a host of a phosphorescent compound. As a host of a phosphorescent compound, M.E.Tompson dopes a new iridium complex to these, and uses various electron-transport-property materials for them. Tsutsui has acquired high luminous efficiency by introducing hole block layers.

[0016]

Although hole block layers are compositionally the same as the electron transport layer currently used for the usual organic EL device, Since the function in which the function prevents movement of a hole which begins to leak from a luminous layer to the negative pole side from an electron transportation function is leading, it is named hole block layers, and it can also be interpreted as a kind of electron transport layer. Therefore, it supposes that hole block layers are also called an electron transport layer in this invention, and the material (hole blocker) used in the layer is also called an electron transport material.

[0017]

Although the host compound of the phosphorescent compound is indicated in detail to C.Adachi et al., Appl.Phys.Lett., 77 volumes, 904 pages (2000), etc., for example, In order to obtain a high-intensity organic EL device, about the character needed for a host compound, the approach from a newer viewpoint is required.

[0018]

However, the composition with which any report may be compatible in the improvement in the light emitting luminance of an organic EL device and endurance is not obtained.

[0019]

[Patent documents 1]

JP,2002-105445,A

[0020]

[Patent documents 2]

JP,2001-257076,A

[0021]

[Problem(s) to be Solved by the Invention]

The purpose of this invention has high luminous efficiency, and is providing an organic electroluminescence element by which manufacture load was reduced and a manufacturing method for the same, the display which has it, a lighting system, and a light source.

[0022]

[Means for Solving the Problem]

The purpose of describing this invention above was attained by the following composition.

[0023]

1. Inside of unit (C) containing molecule which has function of unit (A) containing molecule which has luminescence host's function, unit (B) containing molecule which has function of electron hole transportation, and electron transportation, An organic electroluminescence element having [ multifunctional oligomer or multifunctional polymer which has at least two in intramolecular, and ] a phosphorescence dopant in the same layer.

[0024]

2. Inside of unit (C) containing molecule which has function of unit (A) containing molecule which has luminescence host's function, unit (B) containing molecule which has function of electron hole transportation, and electron transportation, An organic electroluminescence element having [ multifunctional oligomer or multifunctional polymer which has at least two in a repeating unit, and ] a phosphorescence dopant in the same layer.

[0025]

3. Multifunctional oligomer or multifunctional polymer which has both unit (A) containing molecule which has luminescence host's function, and every at least one sort of units (B) containing molecule which has function of electron hole transportation in repeating unit, An organic electroluminescence element having a phosphorescence dopant in the same layer.

[0026]

4. Multifunctional oligomer or multifunctional polymer which has both unit (A) containing molecule which has luminescence host's function, and every at least one sort of units (C)

containing molecule which has function of electron transportation in repeating unit, An organic electroluminescence element having a phosphorescence dopant in the same layer.

[0027]

5. Multifunctional oligomer or multifunctional polymer which has at least one sort at a time three sorts of unit (C) containing molecule which has function of unit (A) containing molecule which has luminescence host's function, unit (B) containing molecule which has function of electron hole transportation, and electron transportation in repeating unit, respectively, An organic electroluminescence element having a phosphorescence dopant in the same layer.

[0028]

6. Multifunctional oligomer or multifunctional polymer which has both units [ every at least one sort of ] (C) containing molecule which has function of unit (B) and electron transportation containing molecule which has function of electron hole transportation in repeating unit, An organic electroluminescence element having a phosphorescence dopant in the same layer.

[0029]

7. Organic electroluminescence element of said three statements, wherein multifunctional oligomer or multifunctional polymer is expressed with said general formula (1).

[0030]

8. Organic electroluminescence element of said four statements, wherein multifunctional oligomer or multifunctional polymer is expressed with said general formula (2).

[0031]

9. Organic electroluminescence element of said five statements, wherein multifunctional oligomer or multifunctional polymer is expressed with said general formula (3).

[0032]

10. An organic electroluminescence element of said six statements, wherein multifunctional oligomer or multifunctional polymer is expressed with said general formula (4).

[0033]

11. An organic electroluminescence element of 1-9 given [ said ] in any 1 paragraph, wherein a unit (A) containing a molecule which has a luminescence host's function contains N-phenyl carbazole compound replaced by at least one or more substituents.

[0034]

12. An organic electroluminescence element of 1-9 given [ said ] in any 1 paragraph, wherein a phosphorescence dopant is an iridium compound, an osmium compound, or a platinum compound.

[0035]

13. An organic electroluminescence element of said 12 statements, wherein an iridium compound is an alt.metal-ized complex containing iridium.

[0036]

14. An organic electroluminescence element of 1-13 given [ said ] in any 1 paragraph having an electrode interface reforming layer on an electrode of an organic electroluminescence element.

[0037]

15. A manufacturing method of an organic electroluminescence element forming at least one organic layer of an organic electroluminescence element of 1-14 given in any 1 paragraph by the applying method.

[0038]

16. A display having an organic electroluminescence element of a statement in said any 1 paragraph of 1-14.

[0039]

17. A lighting system having an organic electroluminescence element of a statement in said any 1 paragraph of 1-14.

[0040]

18. A light source having an organic electroluminescence element of a statement in said any 1 paragraph of 1-14.

[0041]

This invention is explained in detail below.

An organic layer which made a binder distribute a dopant of phosphorescence which used as a binder oligomer or polymer which has two or more functions in this invention, and was excellent in luminous efficiency by producing a film in a high spreading process of productivity, Luminous efficiency is high and an organic electroluminescence element by which manufacture load was reduced and a manufacturing method for the same, a display which has it, a lighting system, and a light source are provided.

[0042]

(Unit (A) containing a molecule which has a luminescence host's function)

A unit (A) containing a molecule which has a luminescence host's function is explained.

[0043]

. Emit light, after forming an excitation state by an electric field with a luminescence host in an organic EL device. It is the material used since what is called a luminescence dopant is fixed, Generally a difference (band gap) of HOMO and LUMO is larger than a luminescence dopant, . As [ have / energy higher than the minimum excitation triplet energy (T1) of a dopant when using a phosphorescence dopant ] Energy transfer is possible to a dopant, or it does not become the hindrance when an electron and a career like an electron hole go into a dopant at a dopant (). [ get blocked and ] the time of HOMO being lower than a dopant (from vacuum level to a long distance), and an electron entering, when an electron hole enters -- a thing in which LUMO is higher than a dopant (close to vacuum ranking) -- it is necessary to be material

[ like ]

[0044]

In especially this invention, since at least one or more sorts of phosphorescence dopants are used, it is more preferred than a phosphorescence dopant that it is a unit which contains as a substructure a high thing (what has a phosphorescence maximum wavelength [ short wavelength / that / of a dopant ]) of T1.

[0045]

As such a substructure, although a carbazole derivative, a biphenyl derivative, a styryl derivative, a benzofuran derivative, a thiophene derivative, an aryl silane derivative, etc. are mentioned, A carbazole derivative and a biphenyl derivative are especially preferred, and a carbazole derivative is the most preferred.

[0046]

However, a vinyl compound which is the monomer at the time of "vinyl polymerization polymer" which a compound of this invention explains later in a general formula (1), In what a vinyl group has linked at least with N of carbazole directly (for example, A-1 of the below-mentioned unit (A), A-2, A-3, A-4, A-5 grade). What a vinyl group has combined at least with N of carbazole via a connecting group (for example, A-6 of the below-mentioned unit (A), A-7, A-8, A-9, A-10 grade) is preferred, and what a vinyl group has combined with a skeleton of carbazole is not so preferred.

[0047]

Although changing with a phosphorescence dopant to be used, speaking in energy diagram, LUMO of HOMO of a unit (A) is not less than 2.2 eV less than 3.1 eV in not less than 5.5 eV less than 6.2 eV preferably.

[0048]

As for a molecular weight of a unit (A), 150 or more and less than 2000 are preferred.

(Unit (B) containing a molecule which has a function of electron hole transportation)

Next, a unit (B) containing a molecule which has a function of electron hole transportation is explained.

[0049]

A hole transporting material in an organic EL device is the material which can serve as a medium which conveys an electron hole supplied from the anode to a luminescence host or a luminescence dopant, Mobility of an electron hole is high, and HOMO is higher than a luminescence host or a luminescence dopant, and it is preferred that it is lower than material (after-mentioned) which forms the anode or an anode buffer layer. In especially this invention, since at least one or more sorts of phosphorescence dopants are used, it is more preferred than a phosphorescence dopant that it is a unit which contains as a substructure a high thing (what has a phosphorescence maximum wavelength [ short wavelength / that / of a dopant ])



of T1.

[0050]

As such a substructure, although a triphenylamine derivative, a phthalocyanine derivative, a porphyrin derivative, etc. are mentioned, a triphenylamine derivative is especially preferred. A mere triphenylamine of electron hole transportability is insufficient, and it is not desirable.

[0051]

When a unit (B) expresses a triphenylamine derivative, it is specifically preferred that at least one connecting group and at least two substituents replace by a triphenylamine skeleton, and as for a molecular weight of a unit (B), 280 or more and less than 2000 are preferred.

[0052]

Speaking in energy diagram, a thing in which HOMO of a unit (B) is higher than a luminescence host portion and/or an electron transportation portion of this invention which are used into the same molecule (close to vacuum level) being preferred.

[0053]

(Unit (C) containing a molecule which has a function of electron transportation)

Next, a unit (C) containing a molecule which has a function of electron hole transportation is explained.

[0054]

A hole transporting material in organic electroluminescence is the material which can serve as a medium which conveys an electron supplied from the negative pole to a luminescence host or a luminescence dopant, A thing also with high (close to vacuum level) the negative pole or a twist whose degree of electron transfer is high and in which LUMO is lower than a luminescence host or a luminescence dopant (from vacuum level to a long distance) is preferred. In especially this invention, since at least one or more sorts of phosphorescence dopants are used, it is more preferred than a phosphorescence dopant that it is a unit which contains as a substructure a high thing (what has a phosphorescence maximum wavelength [ short wavelength / that / of a dopant ]) of T1.

[0055]

As such a substructure, although an aromatic heterocyclic compound and a metal complex compound are mentioned, Preferably, a complex which uses a triazole derivative, a thiadiazole derivative, a pyridine derivative, an imidazole derivative, a pyrimidine derivative, a triazine derivative, a phenanthroline derivative, aluminum, Zn, and Be as a central metal is mentioned.

[0056]

As for a molecular weight of a unit (C), less than [ 150 or more ] 2000 are preferred.

Speaking in energy diagram, a thing in which LUMO of a unit (C) is lower than a luminescence host portion and/or an electron transportation portion of this invention which are used into the same molecule (far from vacuum level) being preferred.

[0057]

Even if a unit (A) which contains a molecule which has a luminescence host's function in this invention has electron hole transportability, It may have electron transport property, and a unit (B) containing a molecule which has a function of electron hole transportation may have a luminescence host's function, and a unit (C) containing a molecule which has a function of electron transportation may have a luminescence host's function. Therefore, in this invention, what is necessary is just to have arbitrary two or more out of a unit (A), (B), and (C) in intramolecular, and a unit (A) is not indispensable.

[0058]

What has in intramolecular a monomer which has two kinds of performances, a unit (A) and a unit (C), as a desirable mode of this invention is preferred, and what has in intramolecular a monomer which has three kinds of functions, a unit (A), (B), and (C), is still more preferred.

[0059]

Next, a connecting group of general formula (1) - (4) is explained.

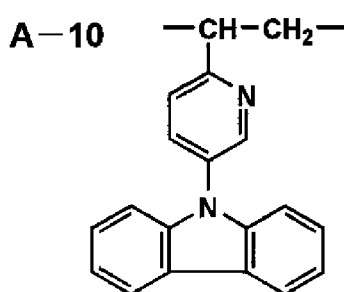
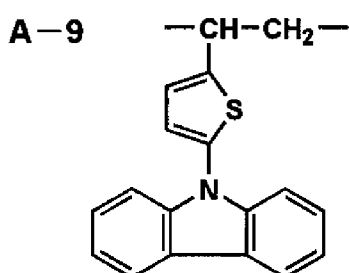
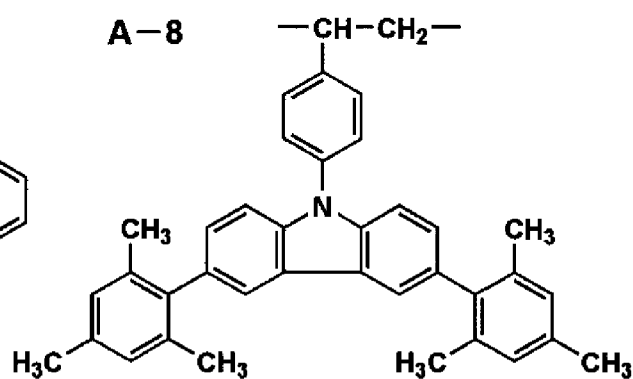
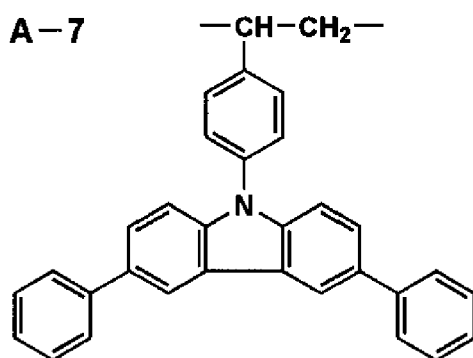
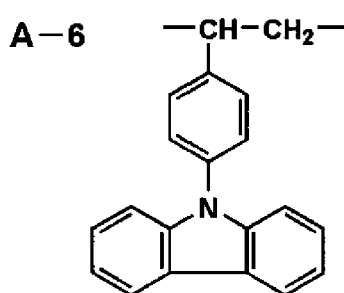
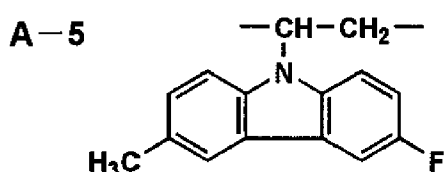
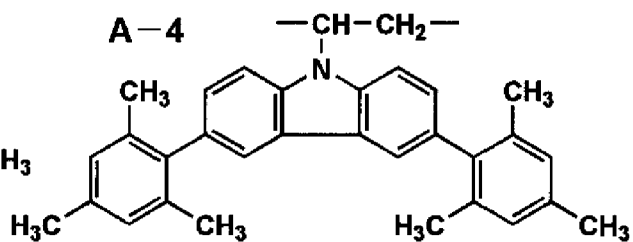
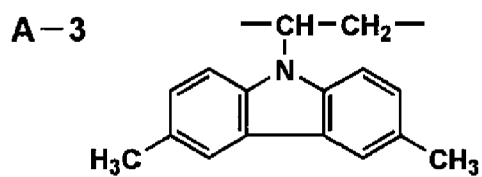
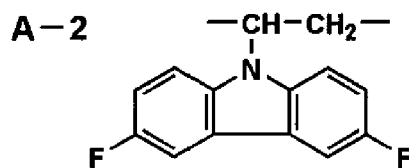
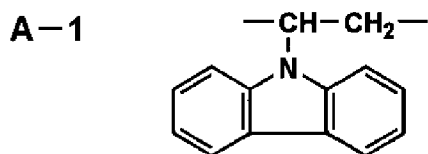
Although  $L_1 - L_5$ ,  $L_1'$ ,  $L_2'$ ,  $L_4'$ , and  $L_5'$  express a connecting group or a joint hand of divalent or \*\* value, Although there is no restriction in particular as a connecting group, said unit (A), (B), When at least combination serves as aryl group direct connection among (C) (for example, A-26, 29, 35, 36, 37 and 38, B-6, 7, 8, 9, 10, 13, 19, 20 and 21, C-13, 14, 15, 16, 17, 18, 20, 21, 22, 23), It is preferred that they are a connecting group (for example, disconjugation allylene groups which intervene hetero atoms, such as alkylene group and -O-alkylene O-, such as a connecting group and a 1,3-phenylene group) of a non-conjugated system, and a connecting group of a conjugated system which has a substituent at least in contiguity. This is for not making phosphorescence wavelength long-wave-ize more than needed.

[0060]

Although an example of a unit (A), (B), (C) and connecting group  $L_1 - L_5$ ,  $L_1'$ ,  $L_2'$ ,  $L_4'$ , and  $L_5'$  is shown below, this invention is not limited to these.

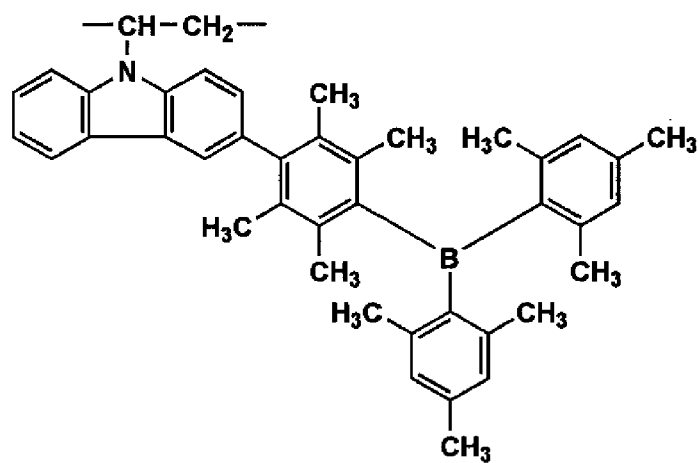
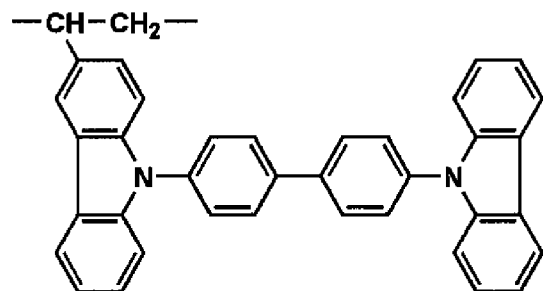
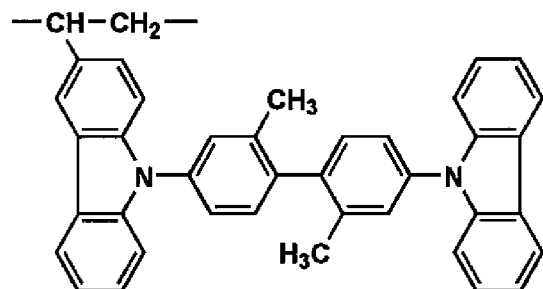
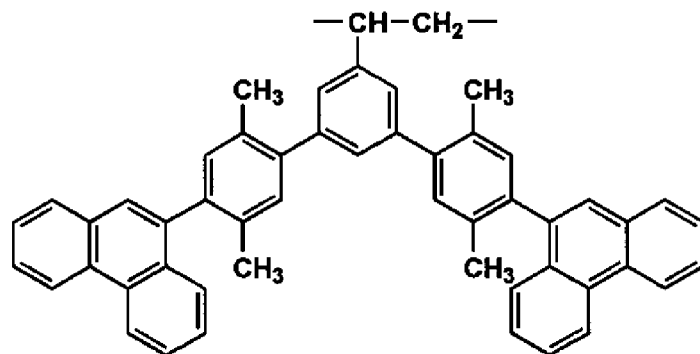
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[Formula 5]



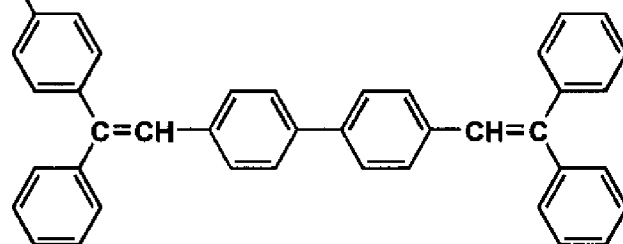
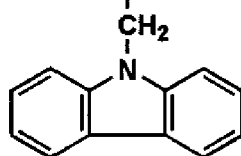
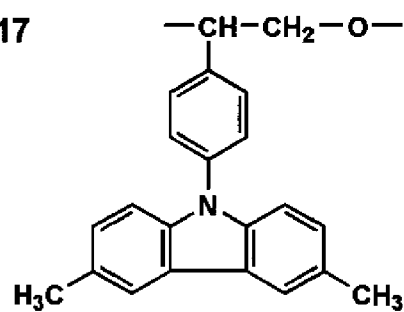
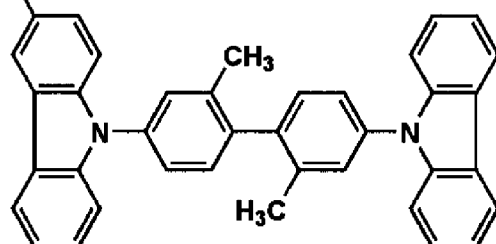
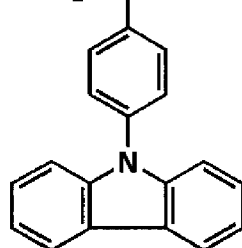
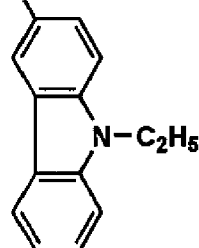
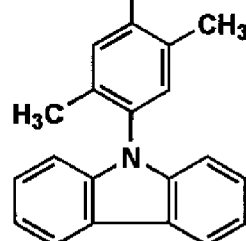
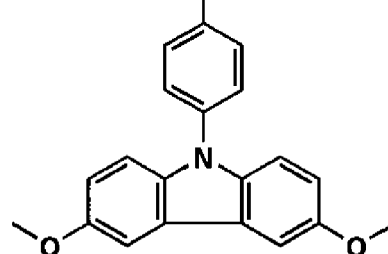
[0062]

[Formula 6]

**A-11****A-12****A-13****A-14**

[0063]

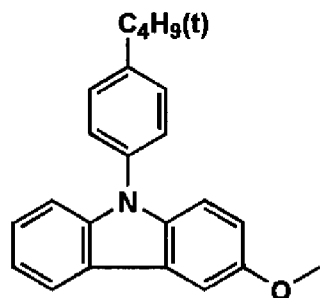
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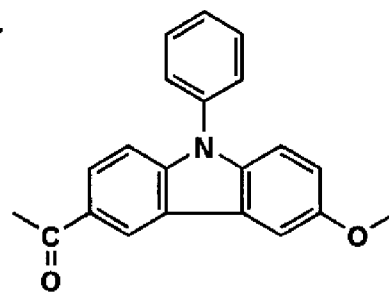
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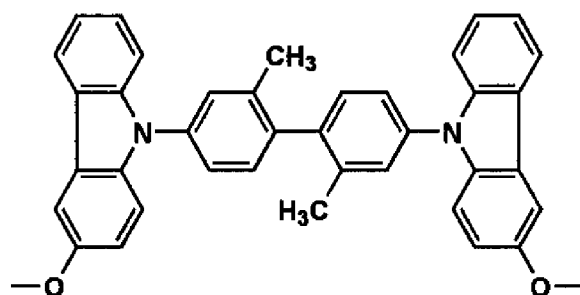
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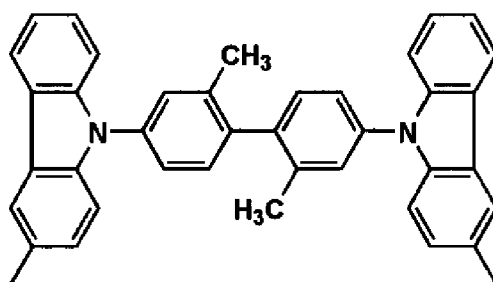
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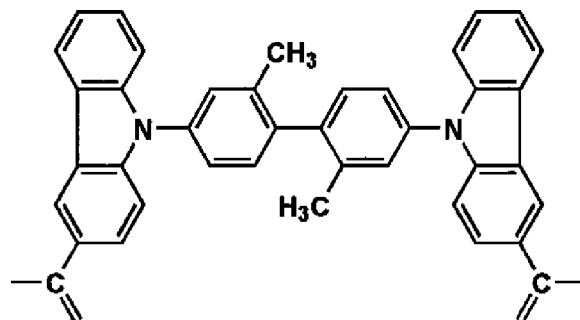
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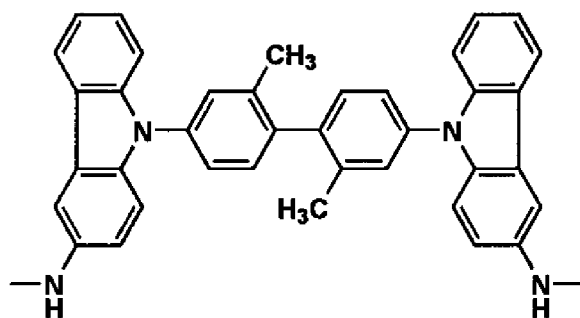
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A-27



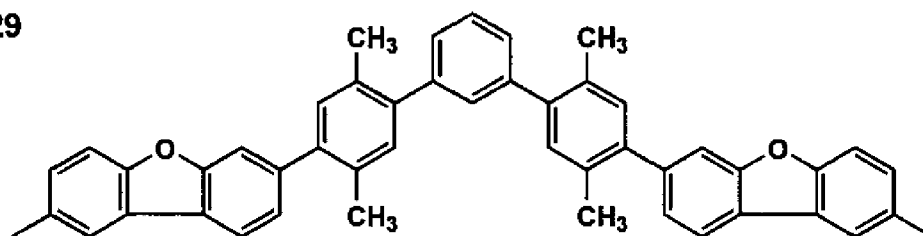
A-28



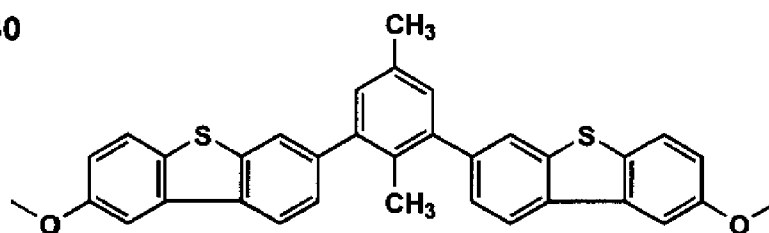
[0065]

[Formula 9]

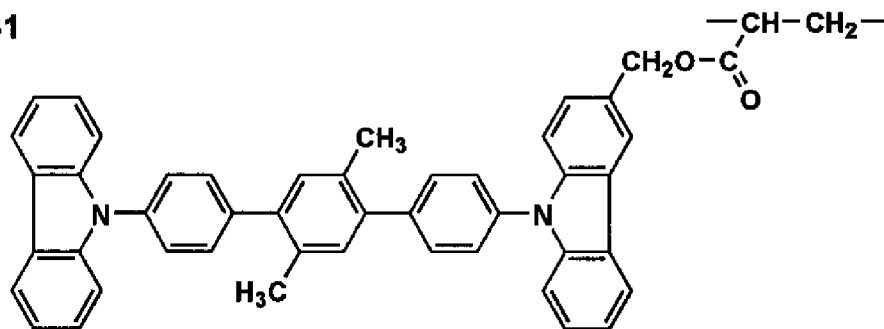
A-29



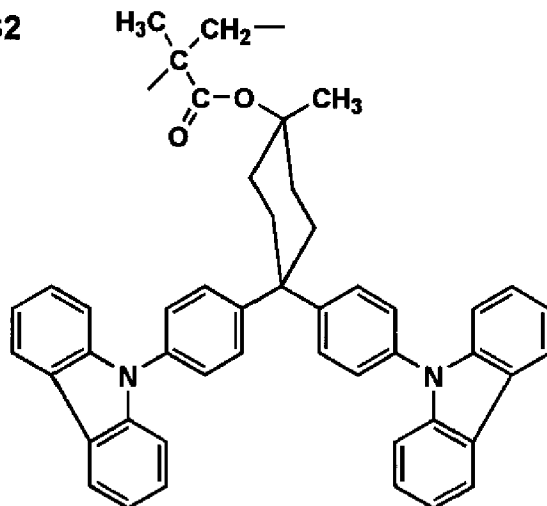
A-30



A-31



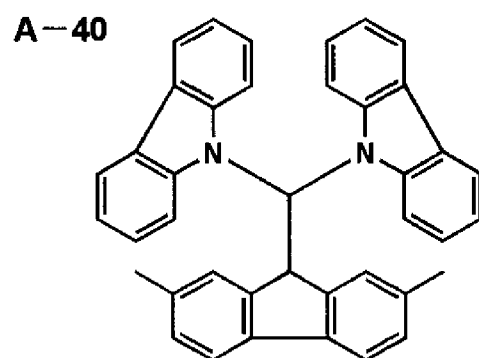
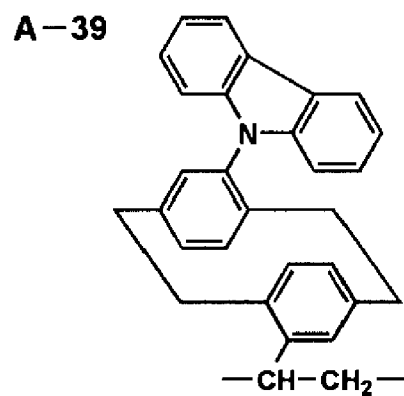
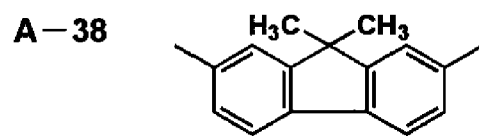
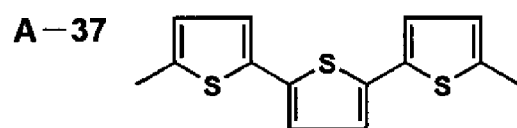
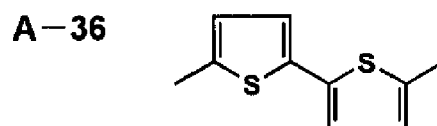
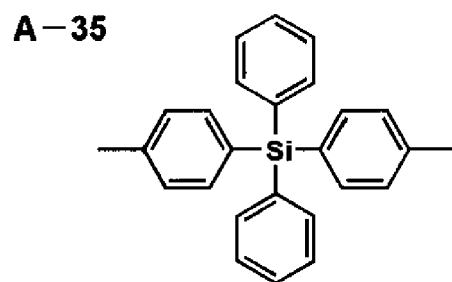
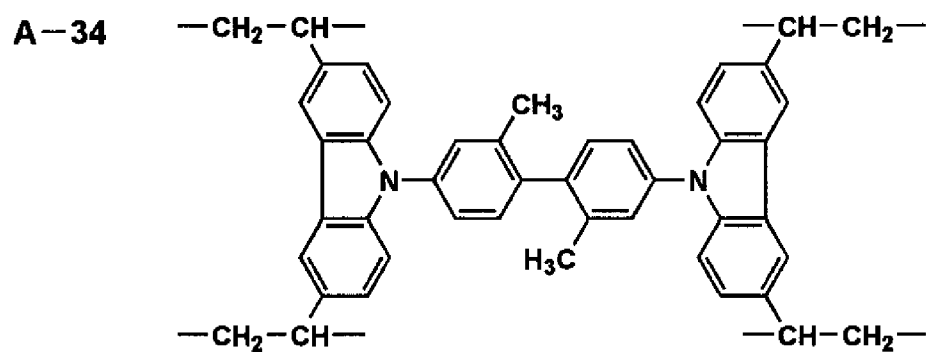
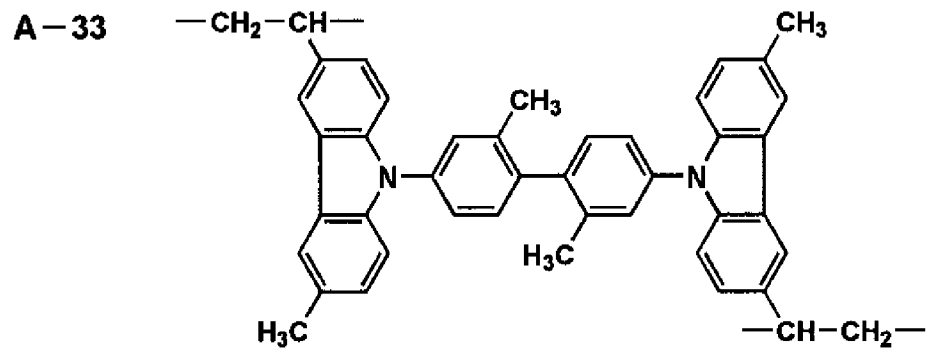
A-32





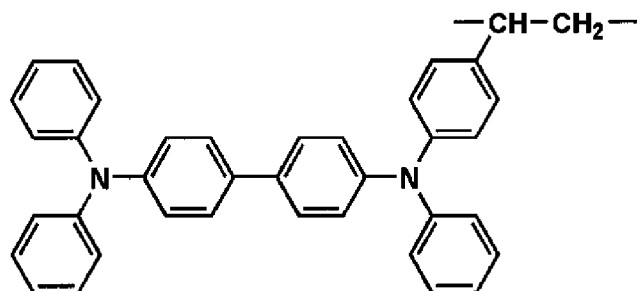
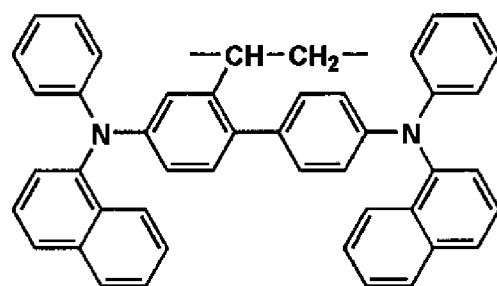
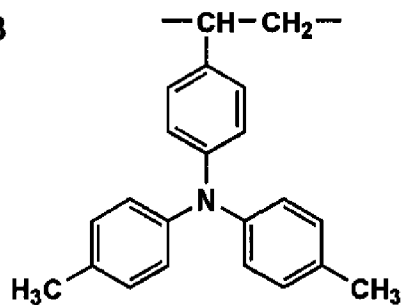
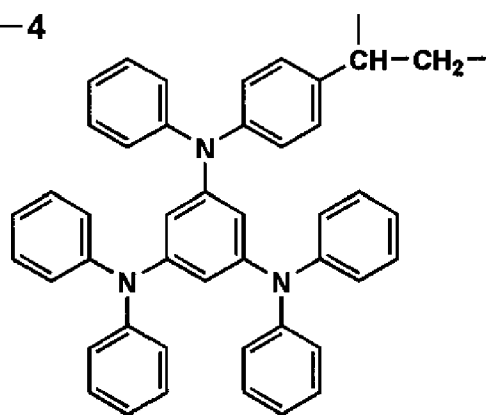
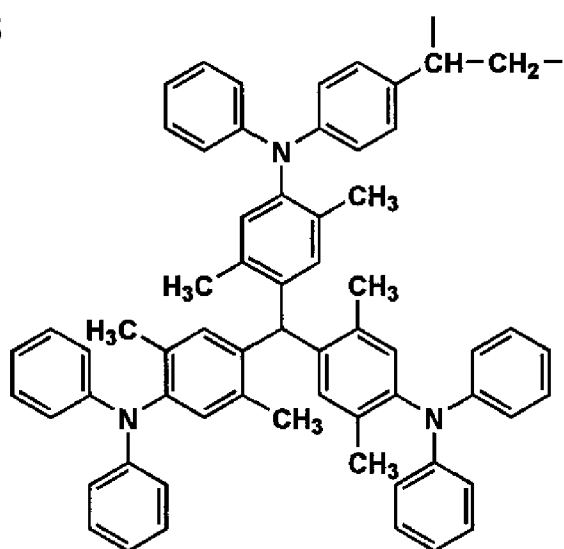
[0066]

[Formula 10]



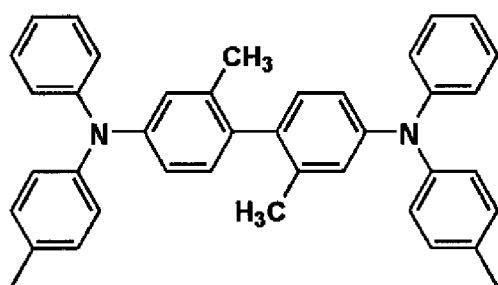
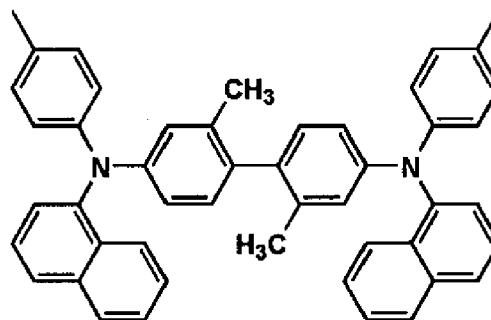
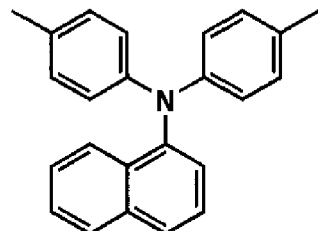
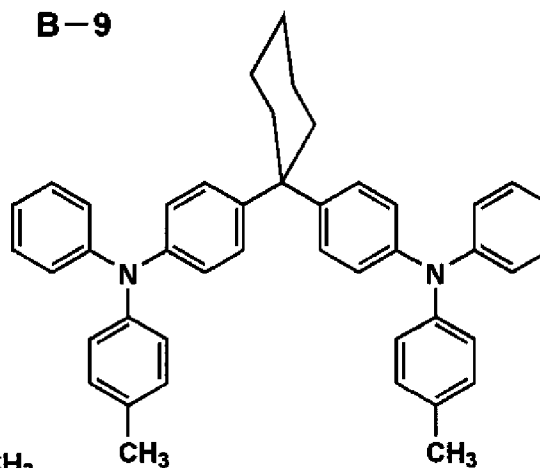
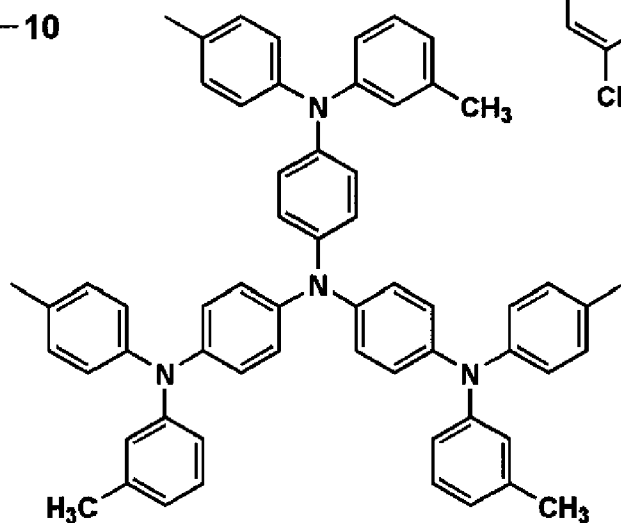
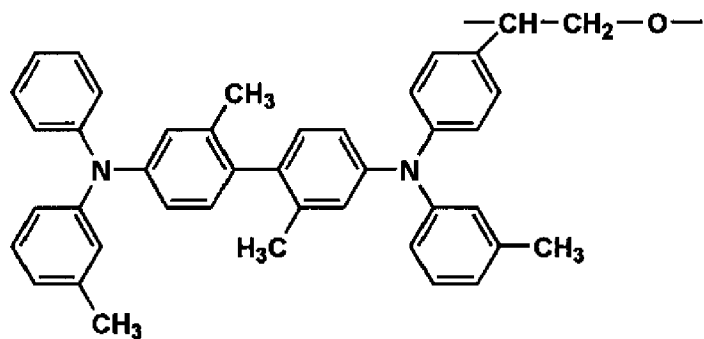
[0067]

[Formula 11]

**B-1****B-2****B-3****B-4****B-5**

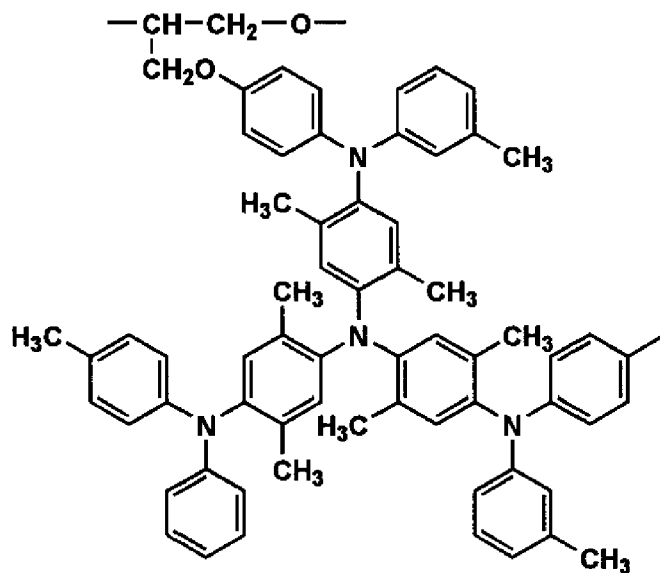
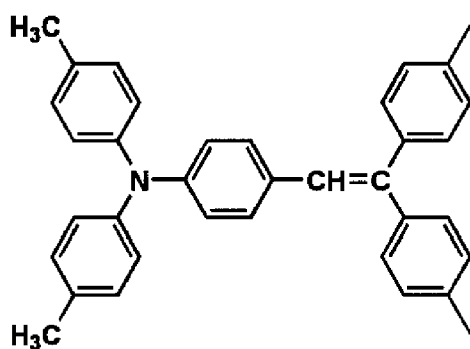
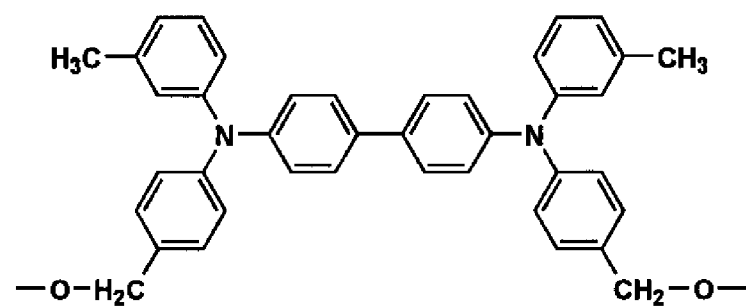
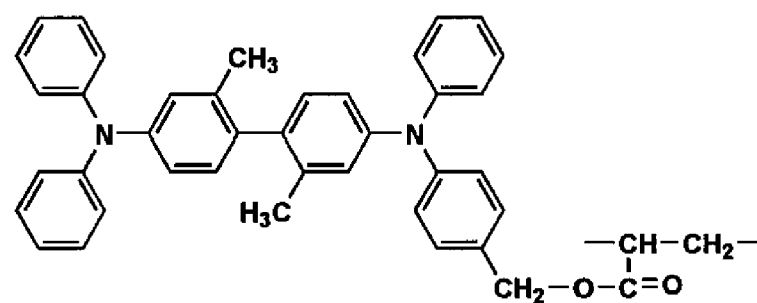
[0068]

[Formula 12]

**B-6****B-7****B-8****B-9****B-10****B-11**

[0069]

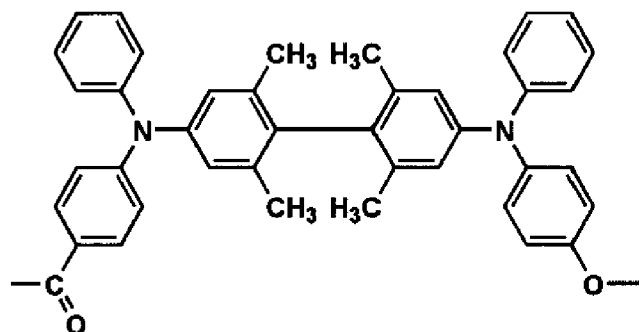
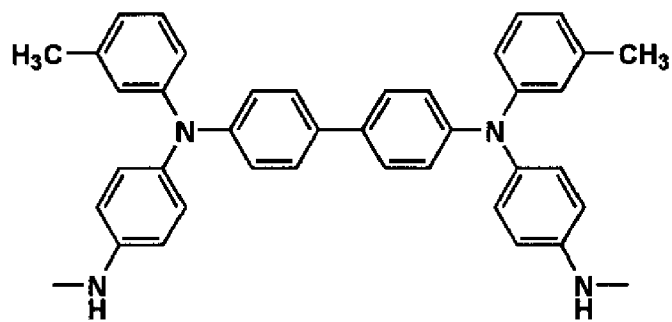
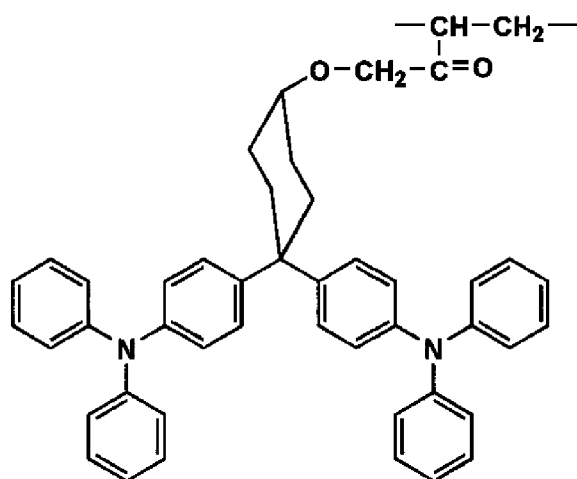
[Formula 13]

**B-12****B-13****B-14****B-15**



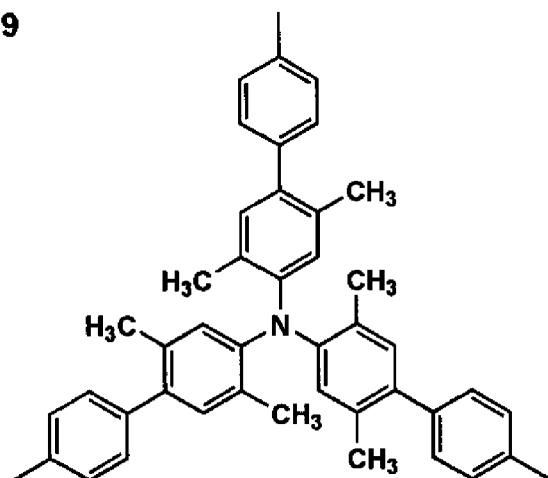
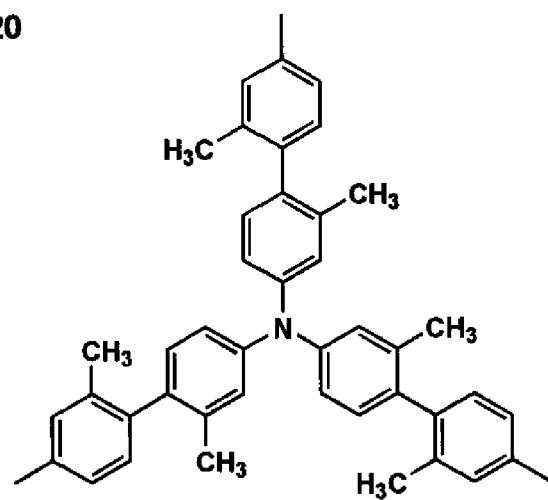
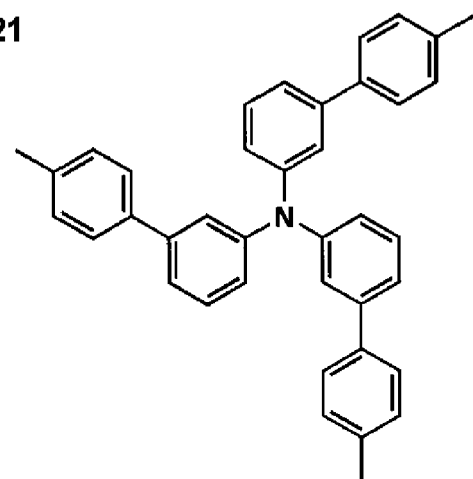
[0070]

[Formula 14]

**B-16****B-17****B-18**

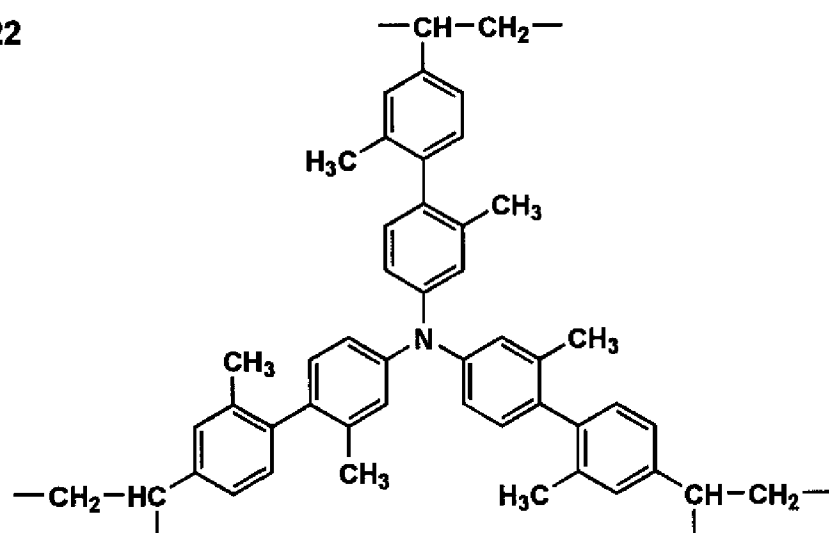
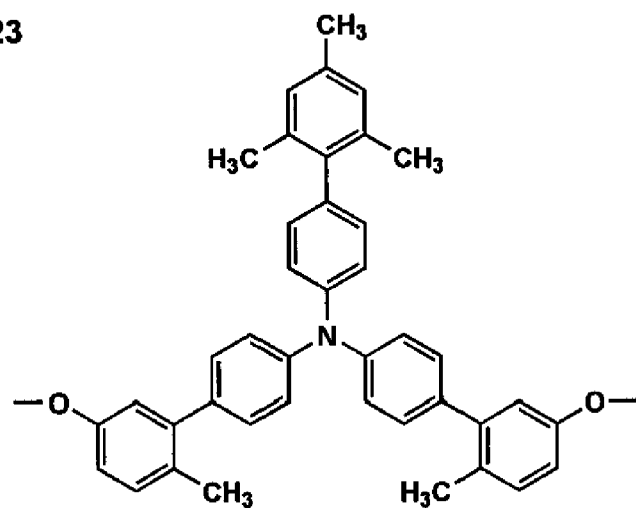
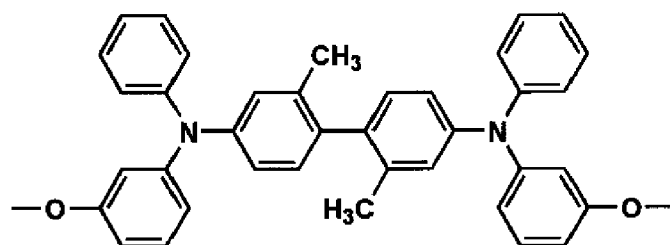
[0071]

[Formula 15]

**B-19****B-20****B-21**

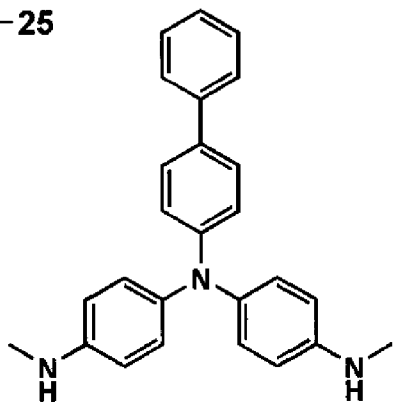
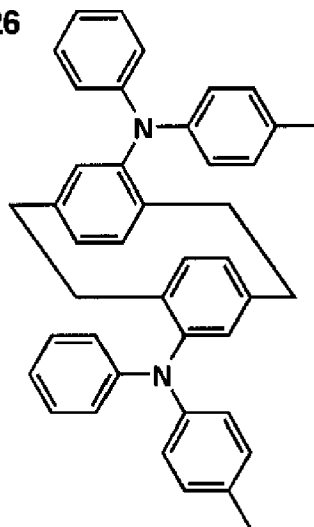
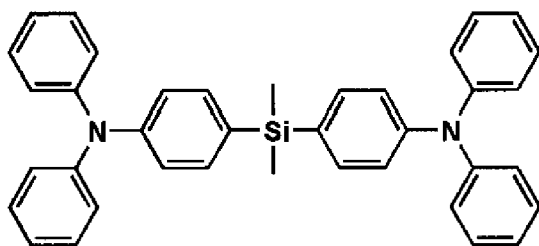
[0072]

[Formula 16]

**B-22****B-23****B-24**

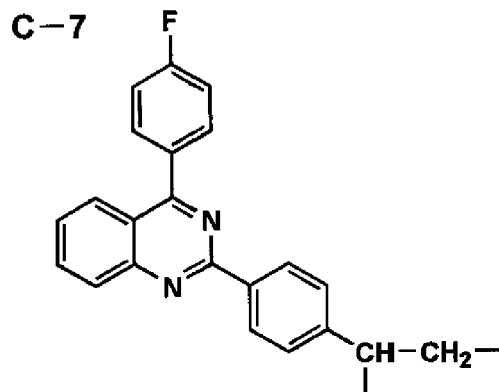
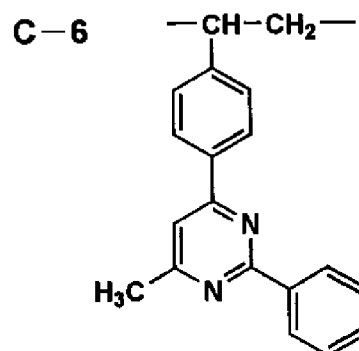
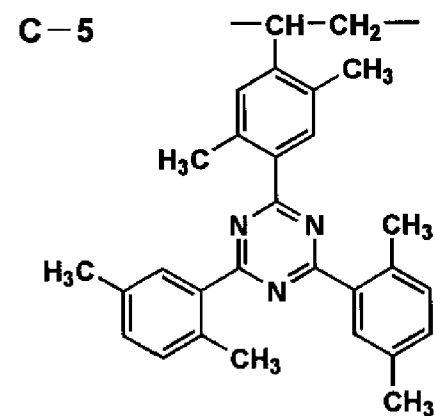
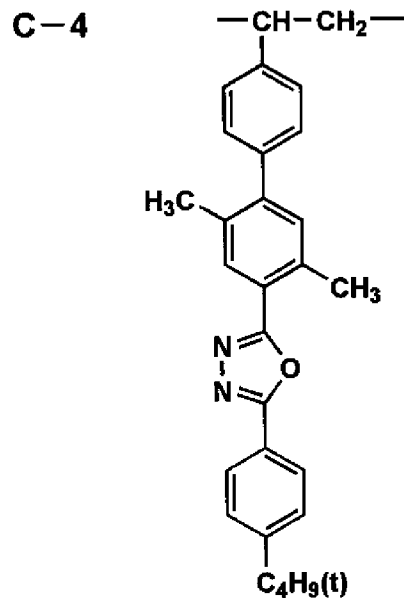
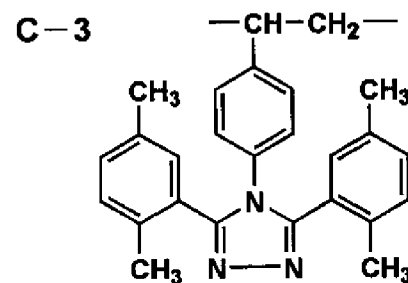
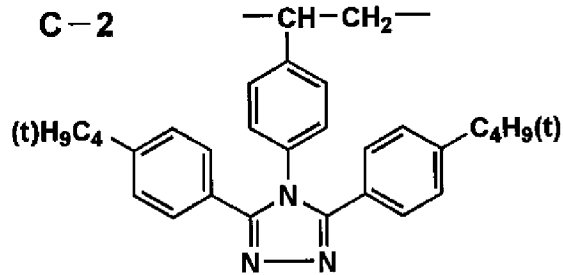
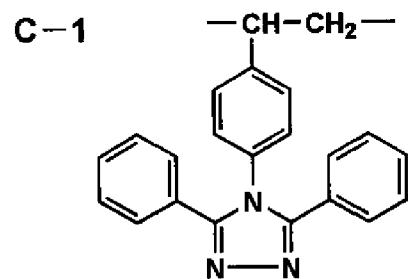
[0073]

[Formula 17]

**B-25****B-26****B-27**

[0074]

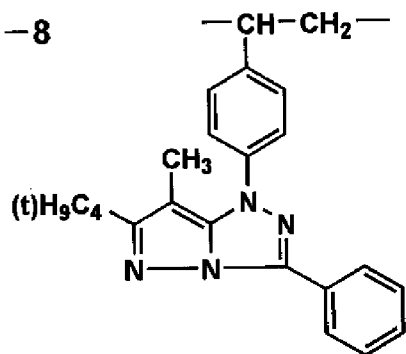
[Formula 18]



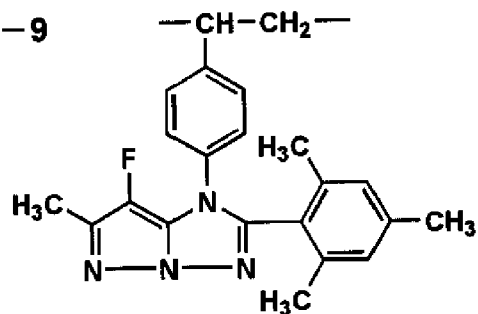
[0075]

[Formula 19]

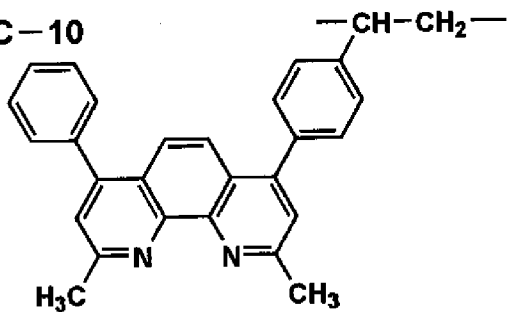
C-8



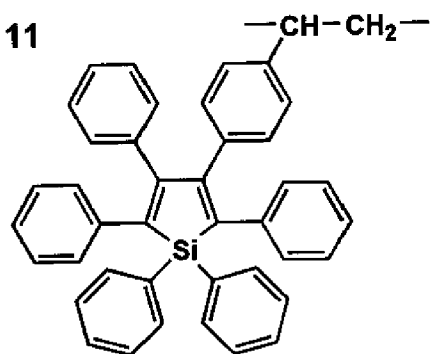
C-9



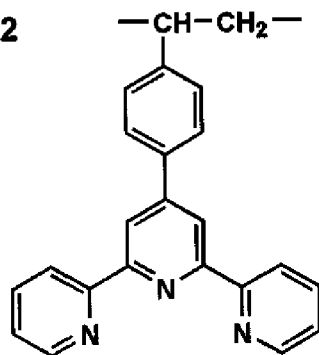
C-10



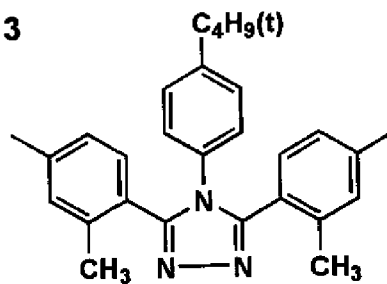
C-11



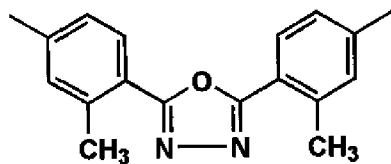
C-12



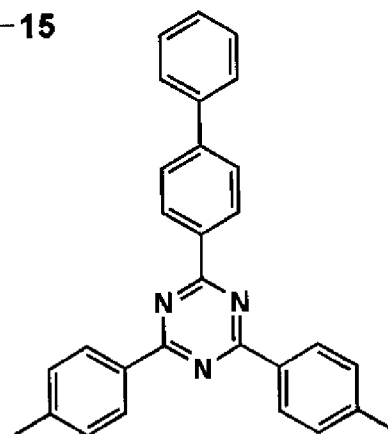
C-13



C-14

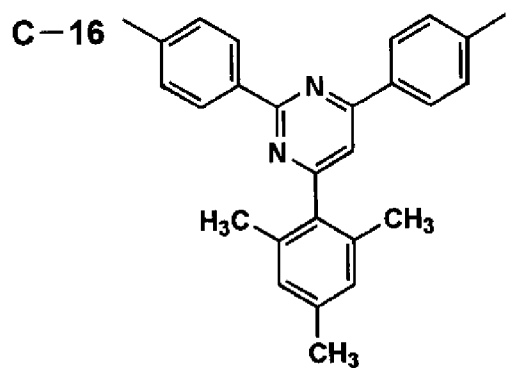


C-15

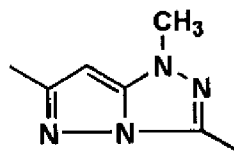


[0076]

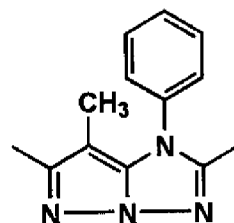
[Formula 20]



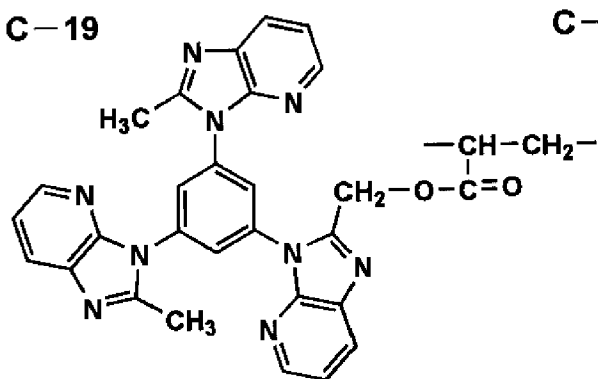
**C-17**



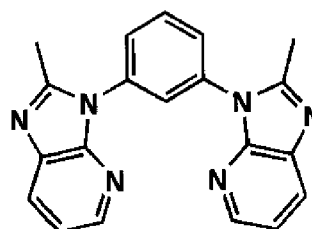
**C-18**



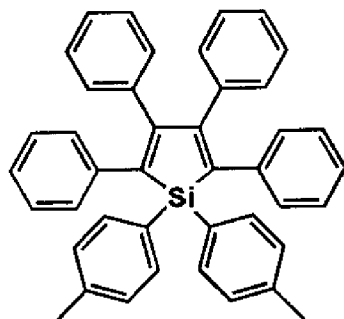
**C-19**



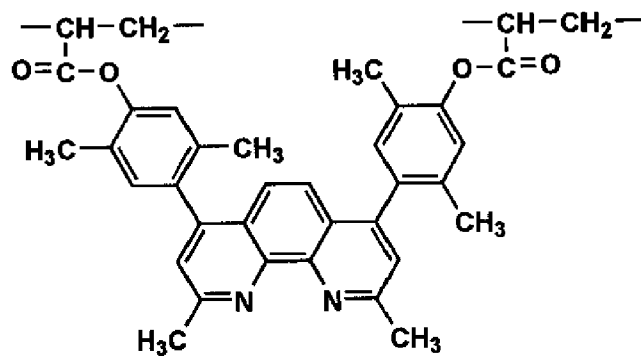
**C-20**



**C-21**



**C-22**

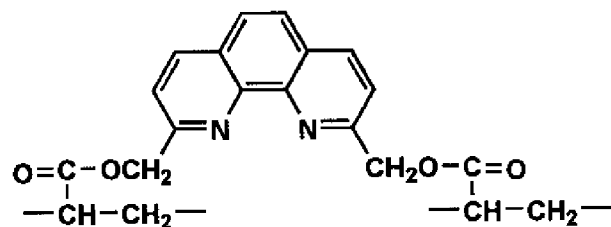




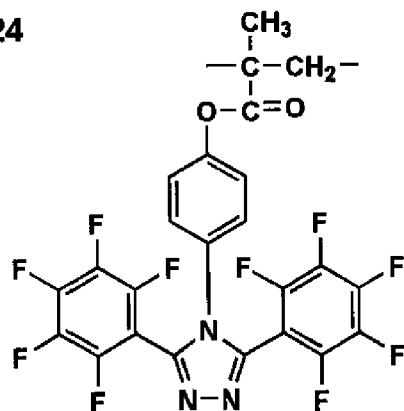
[0077]

[Formula 21]

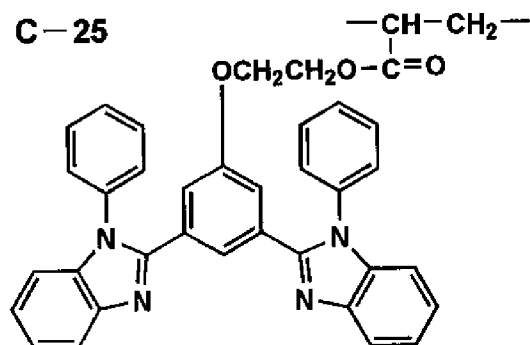
C-23



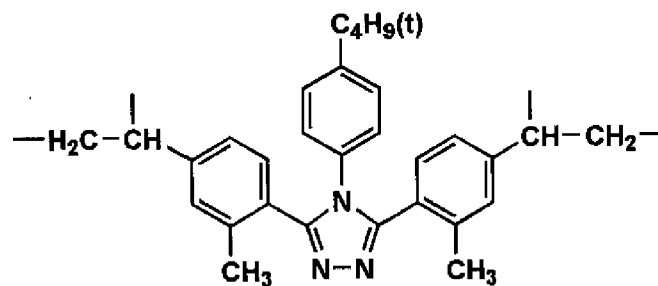
C-24



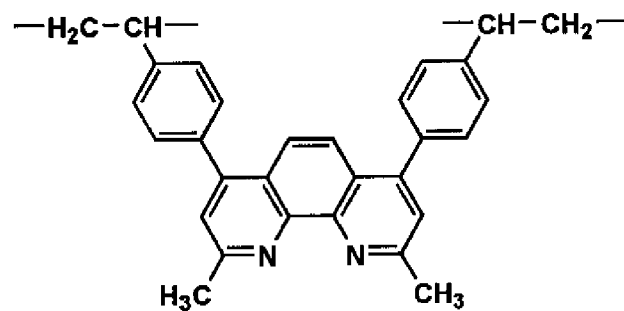
C-25



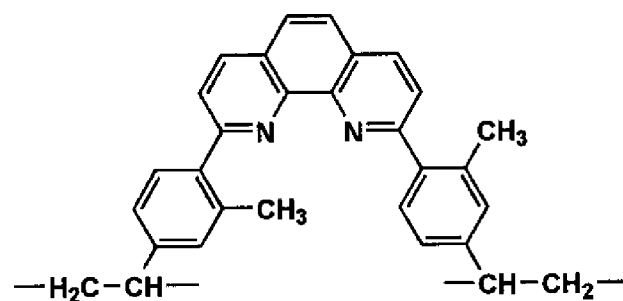
C-26



C-27



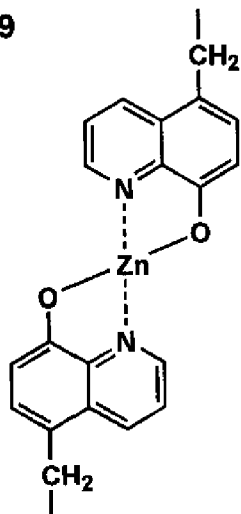
C-28



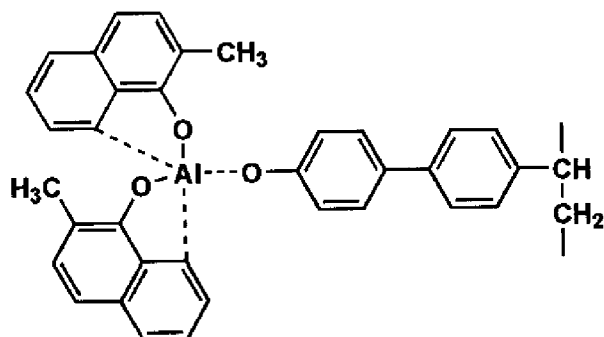
[0078]

[Formula 22]

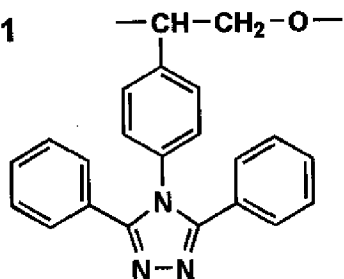
C-29



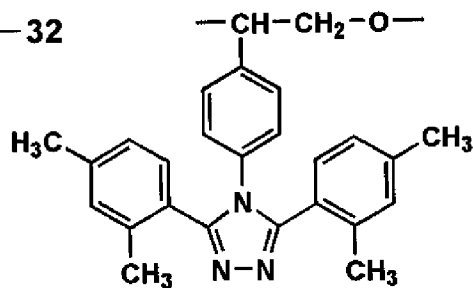
C-30



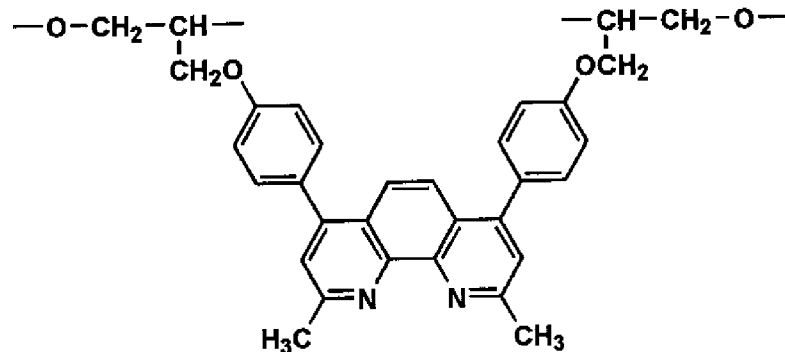
C-31



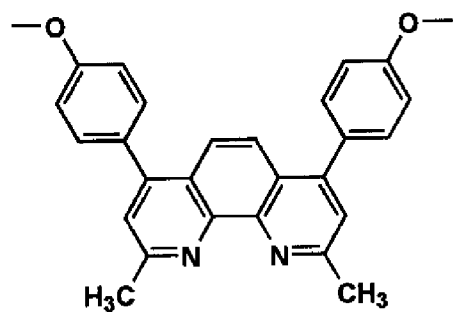
C-32



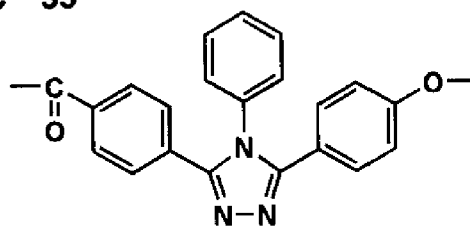
C-33



C-34

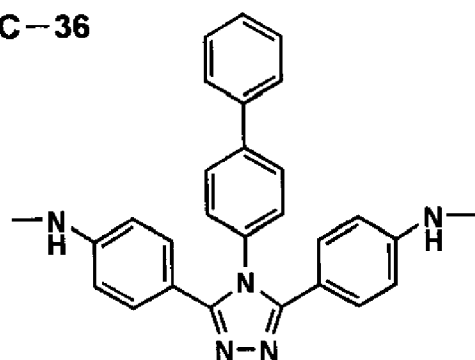
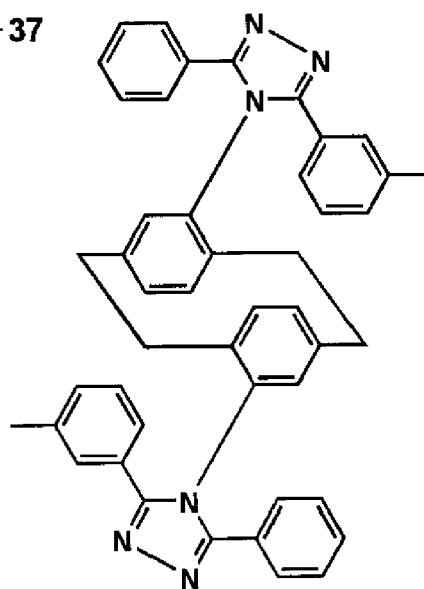


C-35



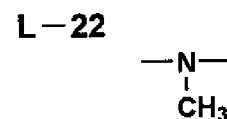
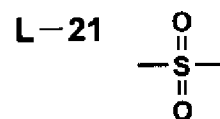
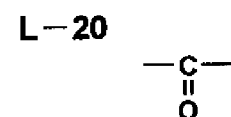
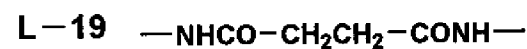
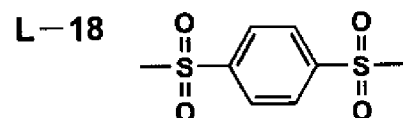
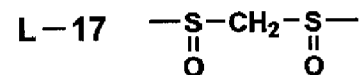
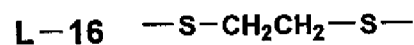
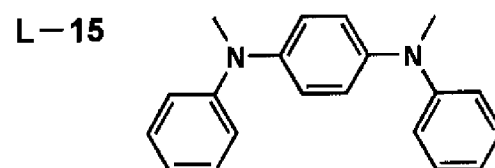
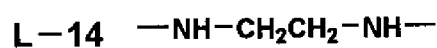
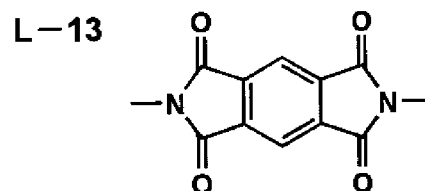
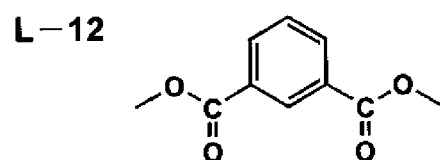
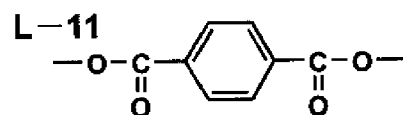
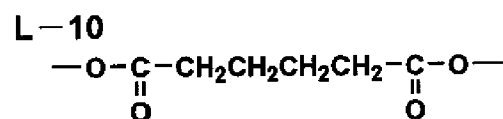
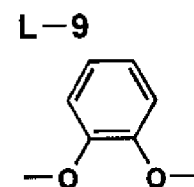
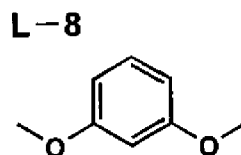
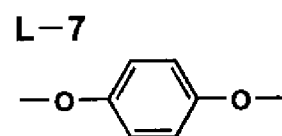
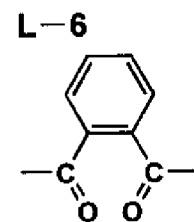
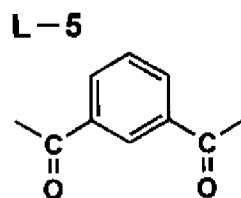
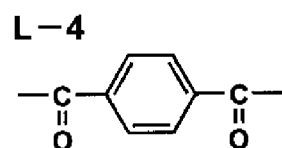
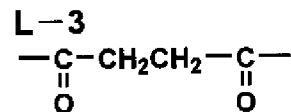
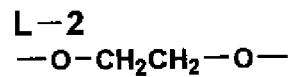
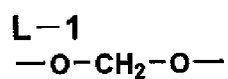
[0079]

[Formula 23]

**C-36****C-37**

[0080]

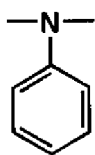
[Formula 24]



[0081]

[Formula 25]

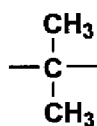
L-23



L-24



L-25



L-26



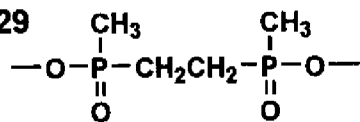
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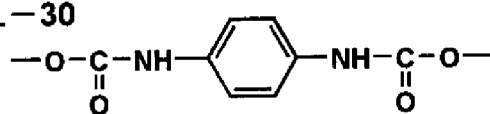
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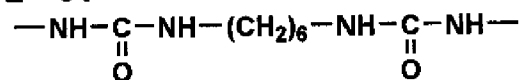
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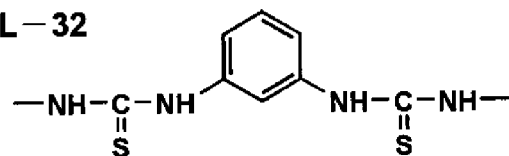
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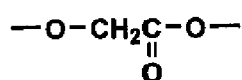
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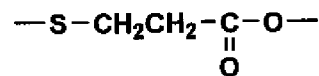
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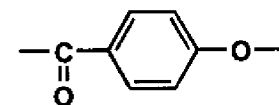
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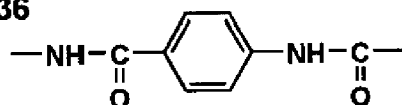
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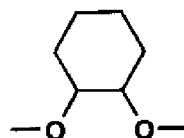
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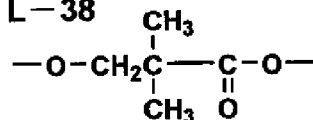
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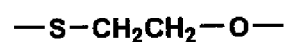
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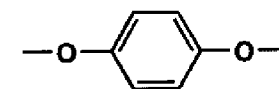
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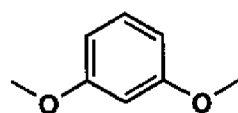
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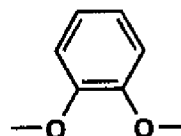
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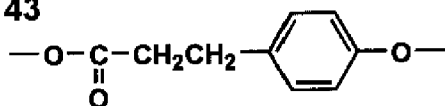
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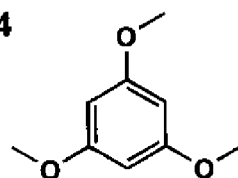
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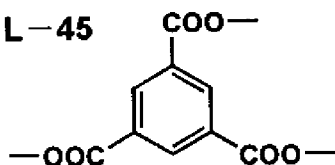
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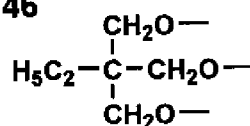
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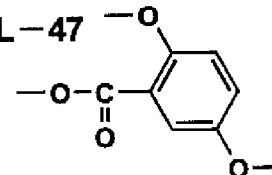
L-45



L-46



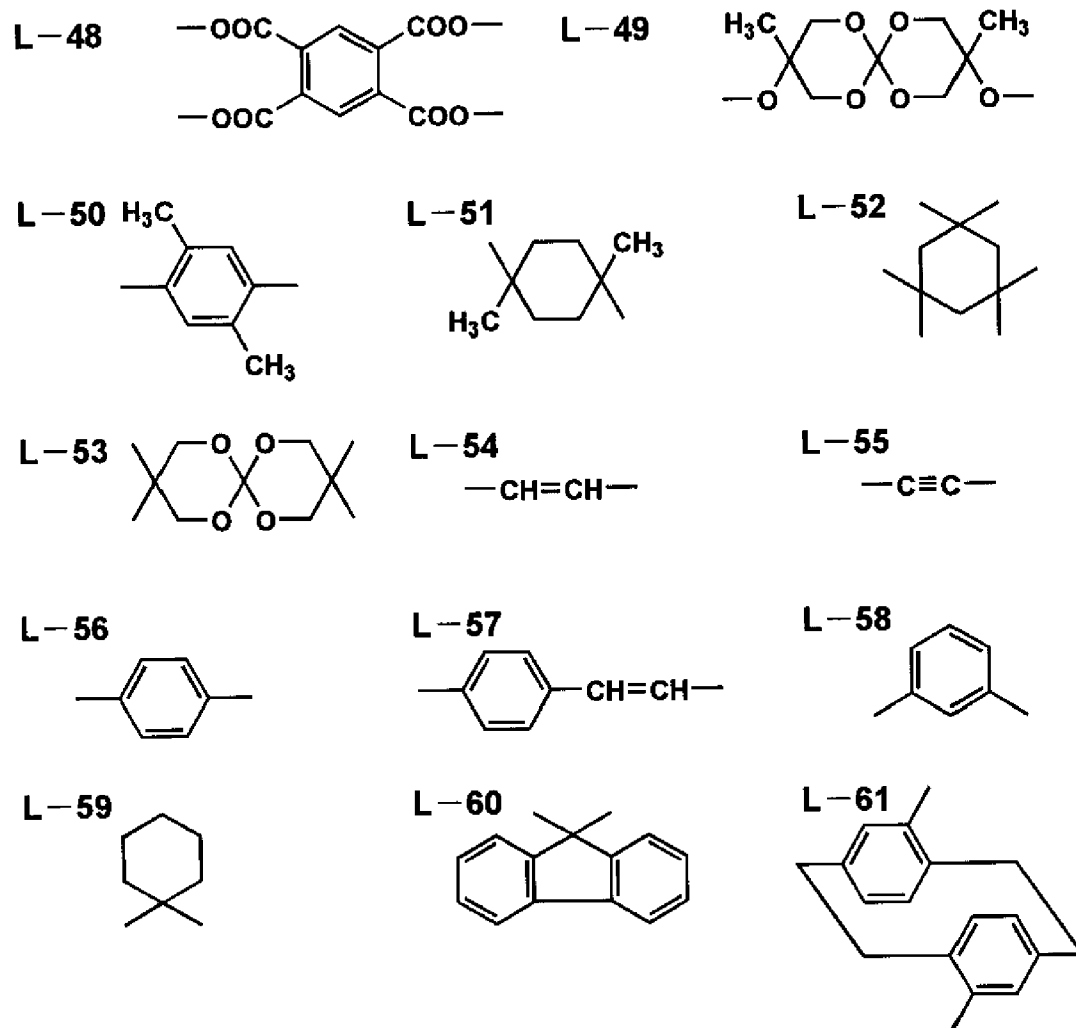
L-47





[0082]

[Formula 26]



[0083]

The unit A, B, and C quoted here and a connecting group are examples, and do not limit this invention. The compound unit and connecting group which were illustrated may be replaced by still more arbitrary substituents. a general formula -- for convenience -- the unit A, B, and C and the connecting group L -- although divalent has indicated all, it may be trivalent and the \*\* value beyond it, and they may combine with each other and may serve as a molecule of arborescence structure or the network structure.

[0084]

Although n1-n9, z1 - z4 express one or more integers independently, respectively, as for the

sum of the sum of the sum of the sum of n1, n2, and z1, n3, n4, and z2, n5, n6, n7, and z3, n8, n9, and z4, it is preferred that it is five or more, and it is still more preferred that it is characterized by being ten or more.

[0085]

Oligomer or polymer (multifunctional polymer is called henceforth) of this invention is explained in detail.

[0086]

In for example, the case of multifunctional polymer having a unit with a luminescence host function expressed with a general formula (1), and an electron hole transportation function. . A and B connect and polymers-ize by condensation or an addition reaction of an ester bond, an amide bond, an ether bond, etc., etc. May be what is called polycondensation polymer or polyaddition polymer, and A and/or B may be what is called vinyl polymerization polymer they connect by a radical reaction including a vinyl group or an acrylate group, and, A and/or B may be [ they ] ring-opening-polymerization polymer including an epoxy group, beta-lactone group, etc.

[0087]

In a general formula (1), when one of A and the B is said vinyl polymerization polymer or ring-opening-polymerization polymer, another side may be polymer or may be a low molecule (compound without a repeating unit).

[0088]

Also in a general formula (2), (3), and (4), it is synonymous, and if it is oligomer or polymer which has two or more functional units in intramolecular, there will be no restriction in particular in a ratio of the bond form and each unit.

[0089]

General formula (1) Although not expressed with - (4), as a desirable thing, in inside, For example, an end of polymer of a single function which consists of a repeating unit containing (a) luminescence host compound, A compound which has an electron hole transportation function and/or an electron transportation function (univalent basis which removed a hydrogen atom or one substituent of arbitrary positions from an electron hole transportability compound and an electron-transport-property compound correctly (henceforth)) electron hole transportability compound residue and electron-transport-property compound residue -- calling -- replaced multifunctional polymer. (b) A compound in which an end of polymer of a single function which consists of a repeating unit containing an electron hole transportability compound has a luminescence host function (univalent basis which removed a hydrogen atom or one substituent of arbitrary positions from a luminescence host compound correctly (henceforth)) Multifunctional polymer replaced by electron-transport-property compound residue and/or it called it luminescence host compound residue, (c) Multifunctional polymer by

which an end of polymer of a single function which consists of a repeating unit containing an electron-transport-property compound was replaced by luminescence host compound residue and/or electron hole transportability compound residue is mentioned.

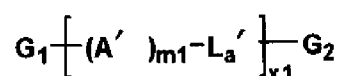
[0090]

The above (a), (b), and (c) is preferably expressed with a following general formula (a).

[0091]

[Formula 27]

一般式(a)



[0092]

(A' expresses among a formula the unit containing a luminescent host compound,  $L_a'$  expresses a connecting group or a mere joint hand, m1 and x1 express one or more integers, and  $G_1$  and  $G_2$  express a substituent independently, respectively.) However, at least one side of  $G_1$  and  $G_2$  expresses electron-transport-property compound residue or electron hole transportability compound residue.

Unit A' containing the luminescent host compound in the general formula (a) shown here is synonymous with what was explained by said A, and synonymous with what also explained  $L_a'$  by said connecting group  $L_1 - L_4$ . As for  $m1+x1$ , it is preferred that it is five or more.

[0093]

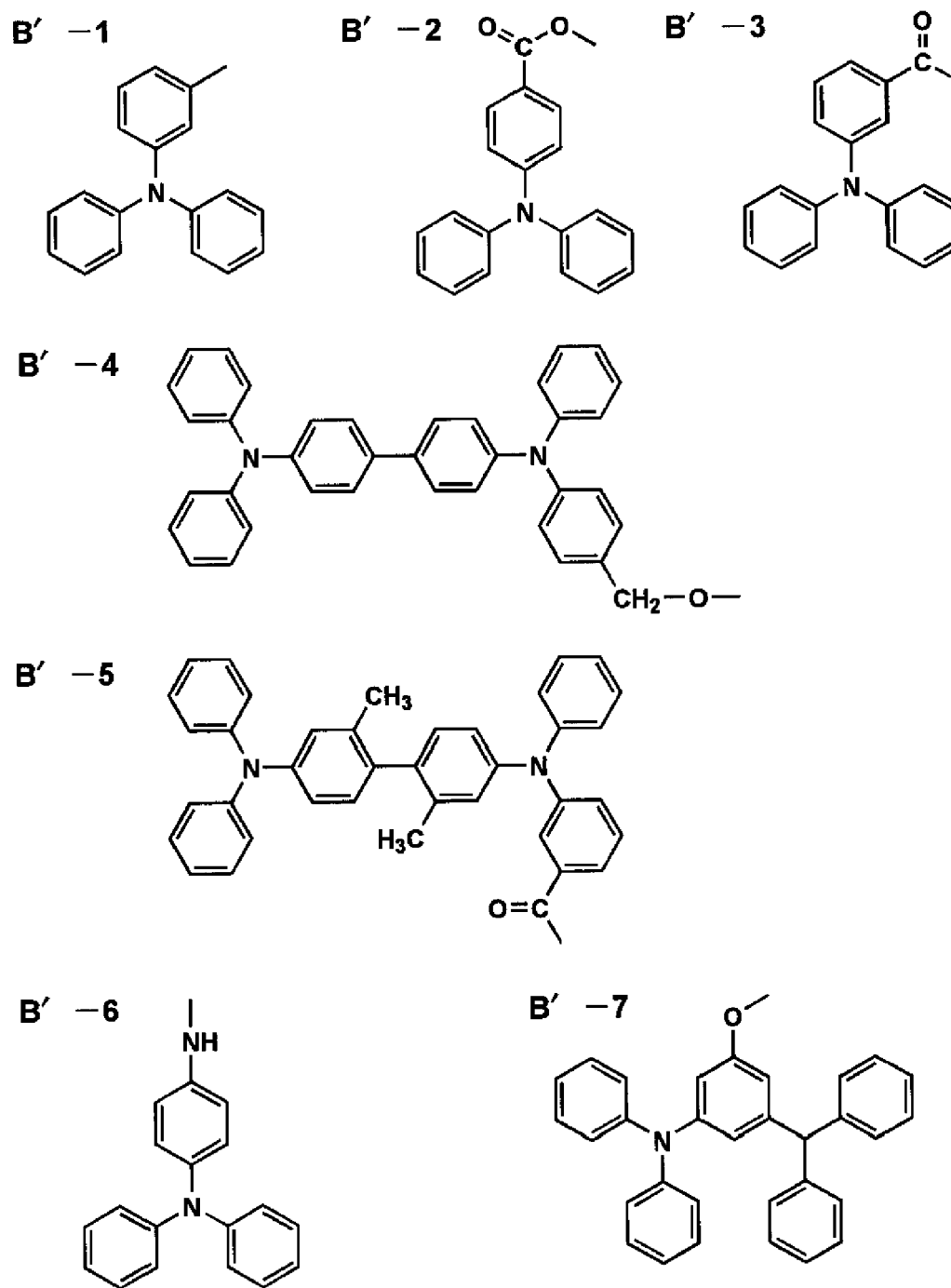
In a general formula (a), although either or both express electron-transport-property compound residue or electron hole transportability compound residue independently, respectively and the definition certainly has them,  $G_1$  and  $G_2$ , [ synonymous with above it ] It leaves only one illustrated combinable part (tip of the joint hand in the example of a compound) of the unit B and the unit C more preferably, and what replaced a hydrogen atom or arbitrary substituents by the other joint hand is mentioned.

[0094]

Although a desirable example is shown below, it is not limited to these.

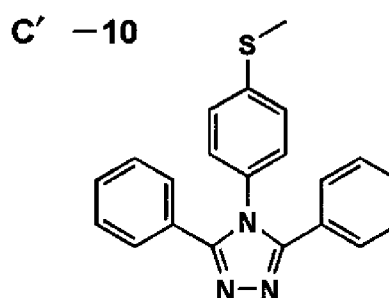
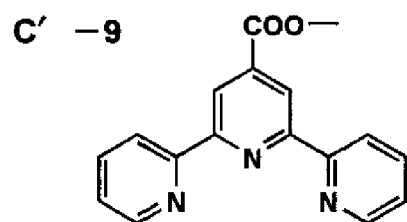
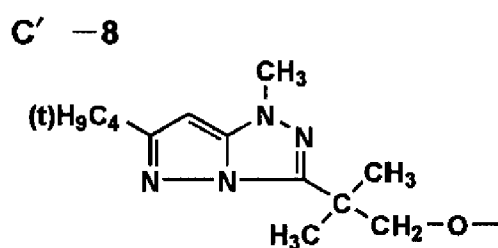
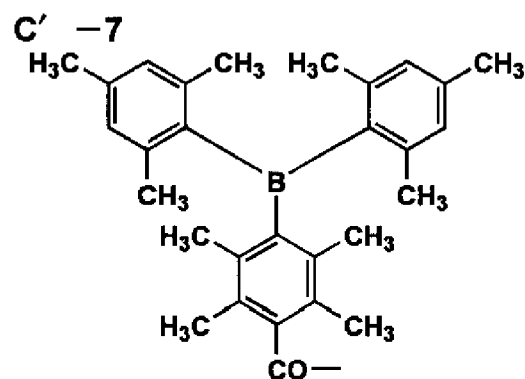
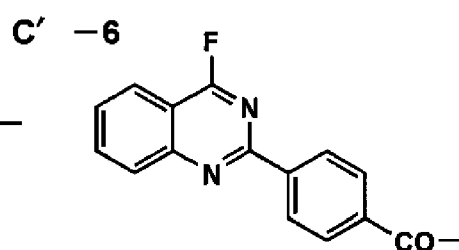
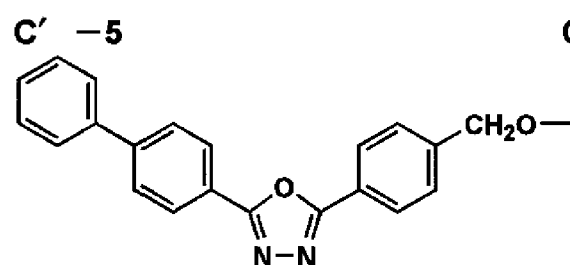
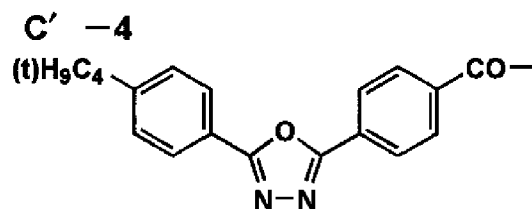
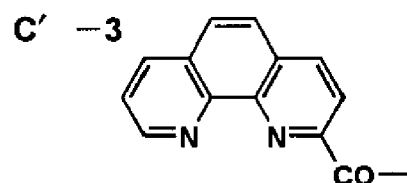
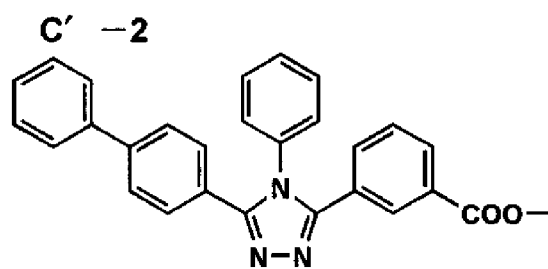
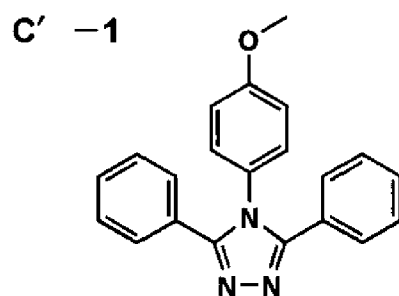
[0095]

[Formula 28]



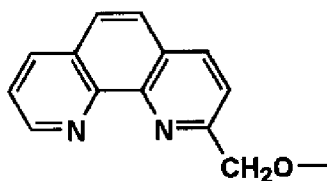
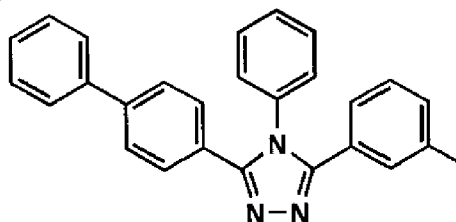
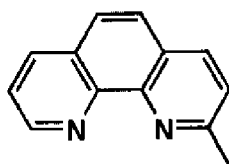
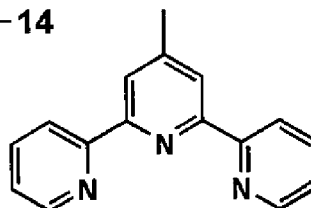
[0096]

[Formula 29]



[0097]

[Formula 30]

**C' -11****C' -12****C' -13****C' -14**

[0098]

moreover -- a low molecular weight compound without a repeating unit which is represented by the above-mentioned B'-1 - 7 and C'-1 - 14 may be sufficient as  $G_1$  and  $G_2$  -- the unit B and the unit C -- arbitrary connecting groups -- or the high molecular compound which polymerized independently may be sufficient.

[0099]

Also as follows, multifunctional polymer of this invention expressed with the above general formula (a) can be written (a connecting group omits).

[0100]

Type 1: B-A-A-A-A...A-B (end cap type)

Type 2: B-A-A-A-A...A-C (end cap type)

Type 3: B-B-B-B-B...B-A-A-A-A...A-R (block polymer type)

Type 4: C-C-C-C-C...C-A-A-A-A...A-R (block polymer type)

Type 5: B-B-B-B...B-A-A-A-A...A-C-C-C-C...C (block polymer type)

The above-mentioned R expresses a hydrogen atom or arbitrary substituents.

[0101]

Changing to a unit (B) containing a compound which has an electron hole transportation function for a unit containing a luminescence host compound of a general formula (a),  $G_1$  and  $G_2$  in that case are luminescence host compound residue (although a definition is synonymous

with above it). It leaves only one combinable part (tip of a joint hand in an example of a compound) of the illustrated unit A more preferably, and becomes a thing which replaced a hydrogen atom or arbitrary substituents by the other joint hand, and electron-transport-property compound residue. Electron-transport-property compound residue is synonymous with above-mentioned it.

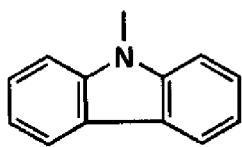
[0102]

Although a desirable example of luminescence host compound residue is shown below, it is not limited to these.

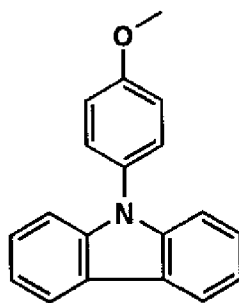
[0103]

[Formula 31]

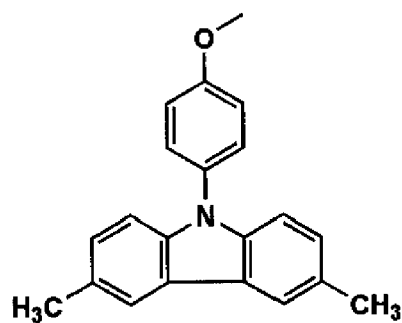
A' -1



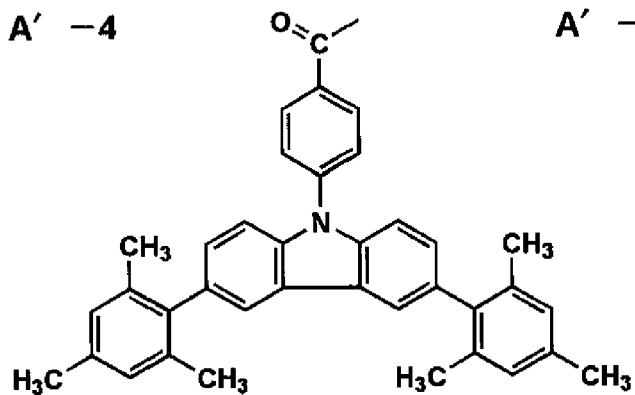
A' -2



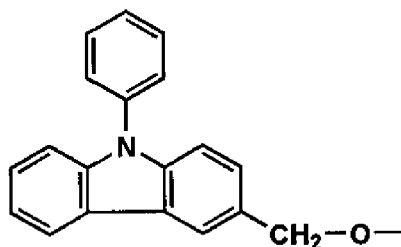
A' -3



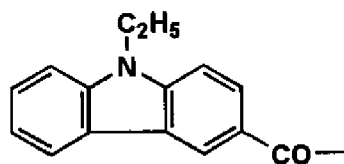
A' -4



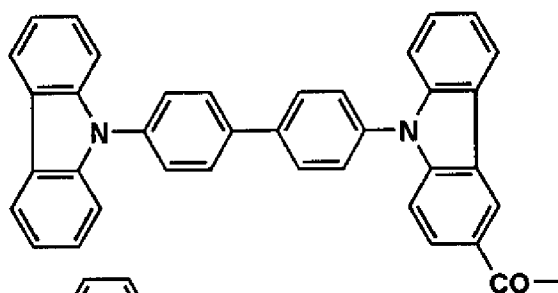
A' -5



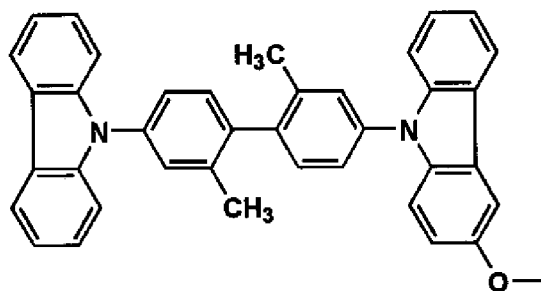
A' -6



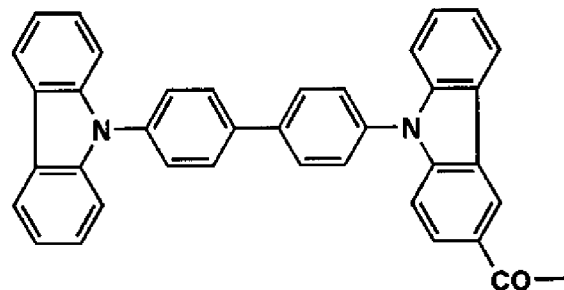
A' -7



A' -8



A' -9





[0104]

moreover -- although a low molecular weight compound without a repeating unit which is represented by above-mentioned A' may be sufficient as  $G_1$  and  $G_2$  -- the unit A -- arbitrary connecting groups -- or it becomes the high molecular compound or electron-transport-property compound residue which polymerized independently.

[0105]

Changing to the unit (C) containing the compound which similarly has an electron transportation function for the unit containing the luminescence host compound of a general formula (a),  $G_1$  and  $G_2$  in that case serve as luminescence host compound residue or electron-transport-property compound residue.

[0106]

This invention will mainly use luminescence originating in phosphorescence, and will contain at least one sort of phosphorescence dopants in an element. therefore, the thing for which the organic materials (namely, organic materials formed from each unit explained below) used by this invention have energy higher than the minimum excitation triplet energy T1 of said phosphorescence dopant -- in other words. Rather than the short wave phosphorescence luminescence maximum wavelength ( $\lambda_D$ ) of the phosphorescence dopant (dopant with the luminescence maximum [ short wave / in them / when there are more than one ]) contained in an organic EL device. It is preferred that the long wave phosphorescence luminescence maximum wavelength ( $\lambda_P$ ) of multifunctional polymer of this invention is almost equivalent, or short wavelength, and it is specifically preferred among a solution that  $\lambda_D$  and  $\lambda_P$  at the time of measuring with liquid nitrogen temperature are the following relations.

[0107]

$(\lambda_P) < (\lambda_D) + 10$  [nm]

It is still more desirable.

$(\lambda_P) < (\lambda_D)$  -- it is a case where a relation is realized.

[0108]

In a case where a phosphorescence dopant which has a blue light component which has a luminescence maximum wavelength to a field of 480 nm or less in an organic EL device especially is contained. Since the necessity of having it and the short wavelength below [ equivalent ] phosphorescence luminescence maximum produces multifunctional polymer of this invention, an electron transport material, a hole transporting material, or a luminescence host currently used with the usual organic EL device which emits light originating in the conventional fluorescence -- the phosphorescence wavelength -- a long wave -- it is too long to

use it as it is

[0109]

That is, in the above systems, it is difficult to use organic electroluminescence material known conventionally as the unit A, B, and C of this invention, and short wavelength formation of phosphorescence wavelength is needed.

[0110]

The following is mentioned as most effective mode.

(1) A beer reel group is made to produce torsion by introducing a substituent at least into contiguity of a connecting position in an aryl group of the conventional organic electroluminescence material (a luminescence host, a hole transporting material, and an electron transport material) and an aryl group which have a beer reel portion, and short wavelength formation of the phosphorescence wavelength can be carried out, (2) By introducing a substituent into the 2nd place (contiguity atom of an atom combined with nitrogen) of an aryl group combined with nitrogen of the conventional organic electroluminescence material (a luminescence host and a hole transporting material) which has a diaryl amino group. A diaryl amino group is made to produce torsion and short wavelength formation of the phosphorescence wavelength can be carried out. For example, A-4, A-8, A-11, A-13, A-14, A-21, A-25, A-26, A-27, A-28, A-29, A-30, A-31, A-33, A-34, B-5, B-6, B-7, B-12, B-15, B-16, B-19, B-20, B-22, B-23, B-24, C-3, C-4, C-5, C-9, C-13, C-16, C-20, C-24, C-26, C-28 grade.

[0111]

The minimum unit which has (3) luminescence host, electron hole transportation, and an electron transportation function as methods other than this. for example, a luminescence host - carbazole and electron hole transportation -- a triphenylamine. electron transportation -- a phenanthroline, triazole, etc. -- the minimum unit -- becoming -- a non-conjugated system connecting group. a method (for example, A-32, A-39, A-40, B-9, B-18, B-26, B-27, C-37) of connecting with (for example, an alkylene group, or an 1,1'-cyclophane group, a silylene group (-Si-), etc.), although it is still more similar to this, (4) It is a connecting group (for example) of a non-conjugated system about the above-mentioned minimum unit. L-1, 2, 3, 5, 8, 10, 12, 13, 14, 16, 17, 19, 24, 25, 26, 27, 28, 29, 31, 32, 33, 34, 37, 38, 39, 41, 43, 44, 45, 46, 49, 51, 52, 53, 57, 58, 59, A method of connecting by 60) is mentioned.

[0112]

Although a substituent as used in the field of this invention shows a metal ion or metal complex residue combinable with an atom, such as an organic group or carbon, nitrogen, oxygen, and sulfur, etc., as a desirable example -- an alkyl group (a methyl group, an ethyl group, and i-propyl group.) A hydroxyethyl group, a methoxymethyl group, a trifluoromethyl group, t-butyl group, alkenyl groups (a vinyl group.), such as a cyclopentyl group, a cyclohexyl group, and

benzyl alkynyl groups (ethynyl group etc.), such as a propenyl group and a styryl group, and an aryl group (a phenyl group.) alkyloxy groups (a methoxy group.), such as a naphthyl group, p-tolyl group, and p-chlorophenyl group Aryloxy groups, such as an ethoxy basis, i-propoxy group, and a butoxy group (phenoxy group etc.), An alkylthio group (a methylthio group, an ethyl thio group, i-pro PIRUKIO group, etc.), arylthio groups (phenylthio group etc.) and a halogen atom (a fluorine atom.) amino groups (a dimethylamino group.), such as a chlorine atom, a bromine atom, and iodine atoms cyano groups, such as a methylamino group and a diphenylamino group, a nitro group, and a heterocycle group (a pyrrole group, a pyrrolidyl group, a pyrazolyl group, an imidazolyl group, a pyridyl group, a benzimidazolyl group, a benzothiazolyl group, a benzoxazolyl group, and a carbazolyl group.) a triazolyl group etc. -- etc. -- it is mentioned. As an aromatic group, the above-mentioned aryl group and heteroaryl groups (a pyrrole group, a pyrazolyl group, an imidazolyl group, a pyridyl group, a benzimidazolyl group, a benzothiazolyl group, benzoxazolyl, etc.) may be mentioned, and each substituent may be replaced by still more arbitrary substituents. Adjoining substituents are condensed mutually and they may form a ring.

[0113]

A molecular weight of multifunctional polymer (oligomer is included) of this invention is 1500 or more preferably, and there is no maximum in particular. When multifunctional polymer of this invention is a polymer including a repeating unit, desirable weight average molecular weight is 2000-1 million, and number average molecular weights are 1000-500000.

[0114]

As for the maximum phosphorescence luminescence maximum wavelength of multifunctional polymer of this invention, it is preferred that it is 480 nm or less in a solution and under liquid nitrogen temperature, and it is more preferred that it is 460 nm or less.

[0115]

Multifunctional polymer of this invention is used as a binder which distributes a phosphorescence dopant or a fluorescence dopant. Although it is common to only use a dopant and multifunctional polymer for it as a method of distributing a phosphorescence dopant or a fluorescence dopant, dissolving multifunctional polymer of this invention in a solvent, In addition, when a connecting group or a reactive functional group which can be connected with multifunctional polymer of this invention is included in a dopant, It may connect via combination of a covalent bond, a coordinate bond or an ionic bond, etc., etc., and when a polymerization nature substituent like a vinyl group is included in a dopant, it may introduce by carrying out copolymerization to the unit (A), (B), and (C) of this invention. Among these, a case where it introduces by copolymerization like the latter is preferred as a method of introducing a dopant into multifunctional polymer.

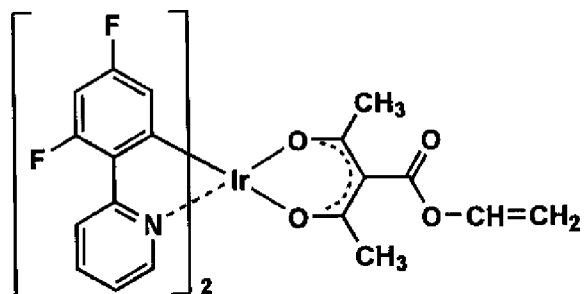
[0116]

Although an example of a concrete compound of a copolymerizable dopant is given to below, this invention is not limited to these.

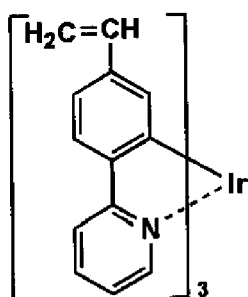
[0117]

[Formula 32]

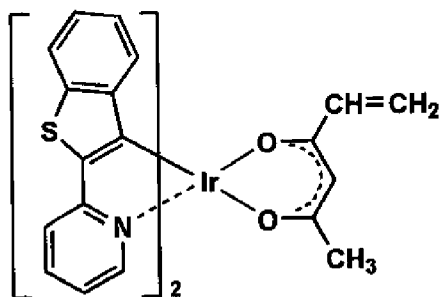
D-1



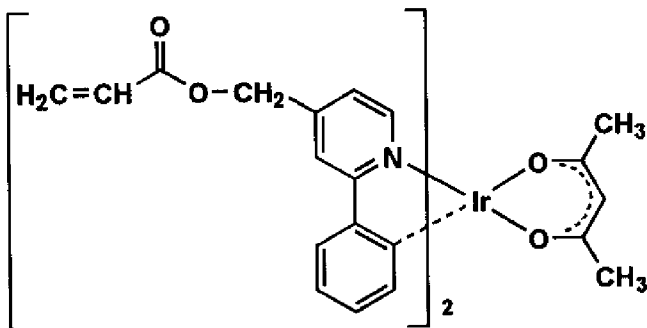
D-2



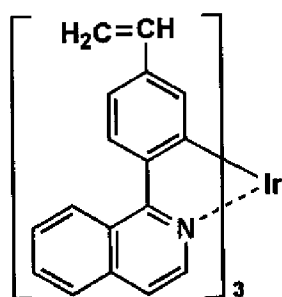
D-3



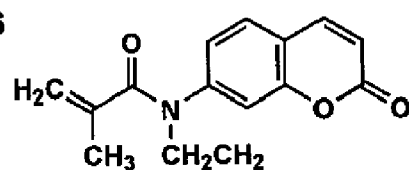
D-4



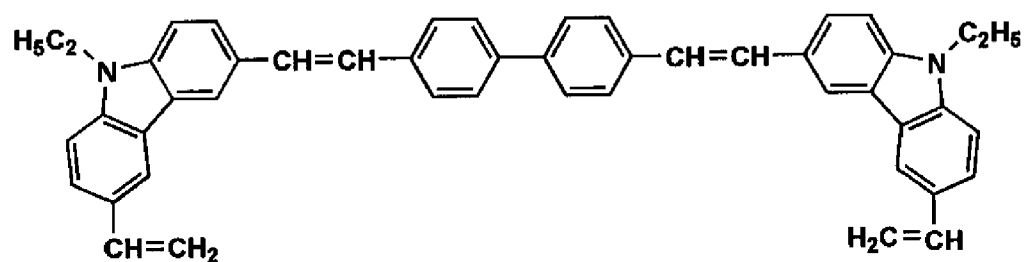
D-5



D-6



D-7



[0118]

In multifunctional polymer of this invention, even though it uses which polymerization form in the ease (viewpoint that high performance can be demonstrated with a small number of layers) of manufacture, what contains three sorts, a luminescence host compound, an electron hole transportability compound, and an electron-transport-property compound, in intramolecular is preferred. When using the monomer from which two sorts of functions are different in multifunctional polymer of this invention, the polymer which combined the luminescence host compound and the electron transport compound is preferred. Among multifunctional polymer of this invention, desirable polymerization forms are ring opening polymerization, a polycondensation, and a polyaddition, and their block copolymerization is more preferred than random copolymerization.

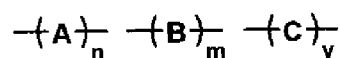
[0119]

The example of multifunctional polymer of this invention is explained below.

1. Vinyl polymerization and ring-opening-polymerization type

[0120]

[Table 1]



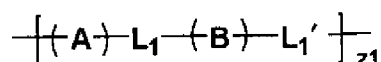
多機能ポリマー	A	B	C	n : m : y	重量平均分子量
1-1	A-1	B-1	—	80 : 20 : 00	24000
1-2	A-4	B-5	—	85 : 15 : 00	42000
1-3	A-11	B-2	—	70 : 30 : 00	19000
1-4	A-13	B-3	—	80 : 20 : 00	21000
1-5	A-14	B-22	—	70 : 30 : 00	31000
1-6	A-8	B-5	—	80 : 20 : 00	36000
1-7	A-6	B-4	—	60 : 40 : 00	14000
1-8	A-31	B-18	—	80 : 20 : 00	21000
1-9	A-32	B-18	—	75 : 25 : 00	290000
1-10	A-31	B-15	—	80 : 20 : 00	31000
1-11	A-32	B-15	—	80 : 20 : 00	33000
1-12	A-18	B-11	—	70 : 30 : 00	16000
1-13	A-17	B-12	—	70 : 30 : 00	11000
2-1	A-2	—	C-1	70 : 00 : 30	28000
2-2	A-3	—	C-3	80 : 00 : 20	21000
2-3	A-8	—	C-10	75 : 00 : 25	19000
2-4	A-13	—	C-5	70 : 00 : 30	26000
2-5	A-11	—	C-28	85 : 00 : 15	20000
2-6	A-12	—	C-4	65 : 00 : 35	31000
2-7	A-14	—	C-7	75 : 00 : 25	31000
2-8	A-31	—	C-19	70 : 00 : 30	40000
2-9	A-31	—	C-22	65 : 00 : 35	28000
2-10	A-32	—	C-23	70 : 00 : 30	29000
2-11	A-32	—	C-22	75 : 00 : 25	31000
2-12	A-16	—	C-31	70 : 00 : 30	21000
2-13	A-18	—	C-33	70 : 00 : 30	24000
2-14	A-18	—	C-32	70 : 00 : 30	23000
2-15	A-17	—	C-32	70 : 00 : 30	20000
2-16	A-39	—	C-3	70 : 00 : 30	21000
3-1	A-1	B-1	C-1	60 : 20 : 20	30000
3-2	A-6	B-7	C-2	50 : 15 : 35	21000
3-3	A-3	B-2	C-10	70 : 10 : 20	28000
3-4	A-8	B-9	C-11	60 : 10 : 30	21000
3-5	A-14	B-21	C-27	60 : 15 : 25	29000
3-6	A-14	B-5	C-30	70 : 10 : 20	18000
3-7	A-13	B-1	C-3	70 : 15 : 15	26000
3-8	A-8	B-5	C-3	70 : 05 : 25	38000
3-9	A-11	B-2	C-3	60 : 10 : 30	21000
3-10	A-13	B-22	C-5	50 : 20 : 30	24000
3-11	A-32	B-18	C-19	70 : 05 : 25	26000
3-12	A-32	B-18	C-24	65 : 15 : 20	21000
3-13	A-31	B-15	C-23	70 : 10 : 20	20000
3-14	A-31	B-15	C-22	70 : 15 : 15	25000
3-15	A-17	B-11	C-31	70 : 10 : 20	25000
3-16	A-16	B-12	C-31	65 : 05 : 30	30000
3-17	A-16	B-11	C-33	75 : 15 : 10	28000
3-18	A-18	B-11	C-31	70 : 10 : 20	21000
3-19	A-18	B-12	C-32	70 : 10 : 20	26000

[0121]

2. Polycondensation and polyaddition type (1)

[0122]

[Table 2]



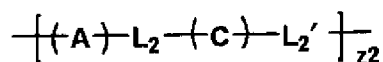
多機能ポリマー	A	L <sub>1</sub>	B	L <sub>1</sub> '	重量平均分子量
4-1	A-22	L-5	B-23	L-5	11000
4-2	A-24	—	B-16	—	8500
4-3	A-27	—	B-17	—	16500
4-4	A-25	L-3	B-24	L-3	15000
4-5	A-29	L-2	B-13	L-2	7000
4-6	A-26	L-11	B-20	L-11	7500
4-7	A-35	L-16	B-19	L-16	10000
4-8	A-37	L-2	B-19	L-2	7500

[0123]

3. Polycondensation and polyaddition type (2)

[0124]

[Table 3]



多機能ポリマー	A	L <sub>2</sub>	C	L <sub>2</sub> '	重量平均分子量
5-1	A-24	—	C-35	—	20500
5-2	A-25	L-3	C-34	L-3	10000
5-3	A-26	L-55	C-13	L-55	6500
5-4	A-26	L-11	C-13	L-11	11000
5-5	A-28	L-5	C-36	L-5	12000
5-6	A-30	L-20	C-34	L-20	14000
5-7	A-35	L-57	C-17	L-57	9000
5-8	A-22	L-50	C-20	L-50	6000
5-9	A-40	L-2	C-37	L-2	11000

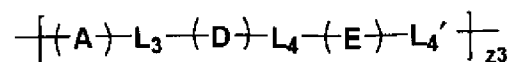


[0125]

4. Polycondensation and polyaddition type (3)

[0126]

[Table 4]



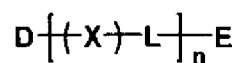
多機能ポリマー	A	L <sub>3</sub>	D	L <sub>4</sub>	E	L <sub>4</sub> '	重量平均分子量
6-1	A-24	—	B-16	—	C-35	—	8000
6-2	A-26	L-3	B-24	L-3	C-34	L-3	7000
6-3	A-27	L-5	C-36	L-5	B-25	L-5	11500
6-4	A-22	L-51	C-34	L-51	B-24	L-51	5000
6-5	A-26	L-30	B-19	L-30	C-13	L-30	19000

[0127]

5. End cap type

[0128]

[Table 5]



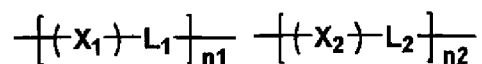
多機能ポリマー	D	X	L	E	重量平均分子量
7-1	H0	A-27	L-2	B' -3	21000
7-2	H0	A-27	L-2	C' -2	18000
7-3	C' -1	A-27	L-2	C' -3	12000
7-4	B' -2	A-40	L-10	B' -1	18000
7-5	C' -2	A-40	L-12	C' -12	9000
7-6	C' -2	A-40	L-12	B' -1	9000

[0129]

6. Block polymer type

[0130]

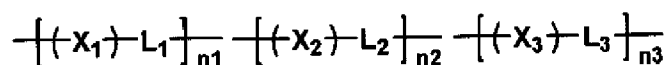
[Table 6]



多機能ポリマー	X <sub>1</sub>	L <sub>1</sub>	X <sub>2</sub>	L <sub>2</sub>	n <sub>1</sub> /n <sub>2</sub>	重量平均分子量
8-1	A-1	—	B-1	—	80/20	14000
8-2	A-1	—	B-18	—	70/30	16000
8-3	A-12	—	B-1	—	70/30	16000
8-4	A-32	—	B-18	—	80/20	14000
8-5	A-9	—	C-1	—	75/25	19000
8-6	A-11	—	C-3	—	90/10	18000
8-7	A-39	—	C-27	—	95/5	22000
8-8	A-25	L-3	C-34	L-3	85/15	12000

[0131]

[Table 7]



多機能 ポリマー	X <sub>1</sub>	L <sub>1</sub>	X <sub>2</sub>	L <sub>2</sub>	X <sub>3</sub>	L <sub>3</sub>	n <sub>1</sub> /n <sub>2</sub> /n <sub>3</sub>	重量 平均分子量
9-1	A-22	L-3	B-24	L-3	C-34	L-3	90/5/5	10000
9-2	A-1	—	B-1	—	C-7	—	60/20/20	21000
9-3	A-39	—	B-18	—	C-1	—	80/10/10	19000
9-4	A-2	—	B-2	—	C-2	—	50/25/25	16000
9-5	A-11	—	B-5	—	C-3	—	70/10/20	14000
9-6	A-13	—	B-5	—	C-10	—	50/20/30	22000

[0132]

7. Except the above

[0133]

[Table 8]

—A<sub>n</sub>—B<sub>m</sub>—C<sub>l</sub>—D<sub>k</sub>—

多機能ポリマー	A	B	C	D	n/m/l/k	重量平均分子量
10-1	A-4	B-1	C-1	D-2	70/10/15/5	17000
10-2	A-11	B-3	—	D-3	80/10/9/1	14000
10-3	A-13	—	C-2	D-7	70/10/15/5	17000

[0134]

The phosphorescent compound (dopant) of this invention is a compound in which luminescence from an excitation triplet is observed, and phosphorescence quantum yields are 0.001 or more compounds in 25 \*\*. It is 0.1 or more still more preferably 0.01 or more preferably.

[0135]

The above-mentioned phosphorescence quantum yield can be measured by the method of a 398 pages (1992 editions, Maruzen) statement of the spectrum II of the 4th edition experimental science lecture 7. Although the phosphorescence quantum yield in the inside of a solution can be measured using various solvents, the above-mentioned phosphorescence quantum yield should just be attained in either of the solvents with an arbitrary phosphorescent compound used for this invention. Preferably, in the periodic table of an element, it is a complex system compound containing the metal of a VIII group, and they are iridium, OUMIUMU, or a platinum complex system compound still more preferably. It is an iridium complex system compound more preferably.

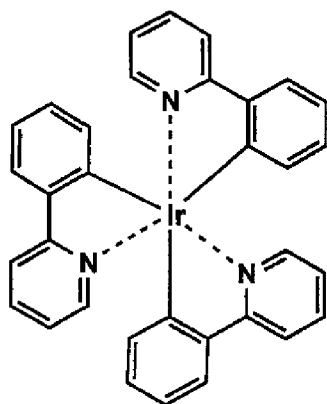
[0136]

Although the example of the phosphorescent compound used for below by this invention is shown, it is not limited to these. These compounds are compoundable by the method of a statement, etc. to Inorg.Chem., 40 volumes, and 1704-1711, for example.

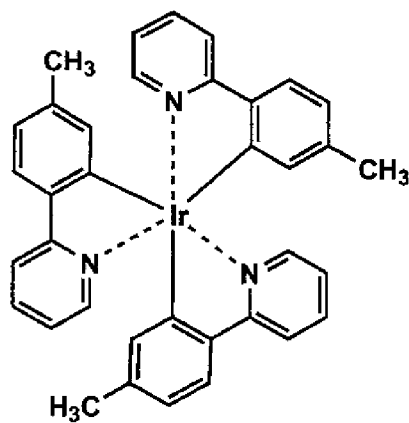
[0137]

[Formula 33]

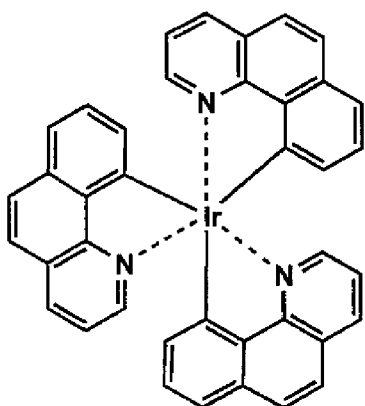
Ir-1



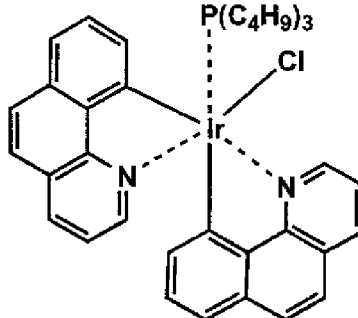
Ir-2



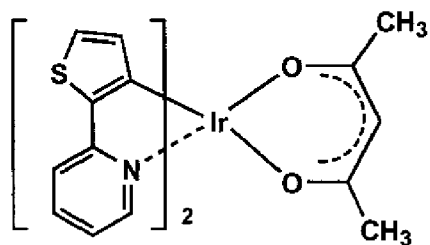
Ir-3



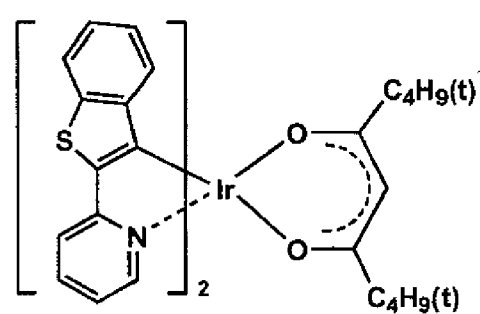
Ir-4



Ir-5



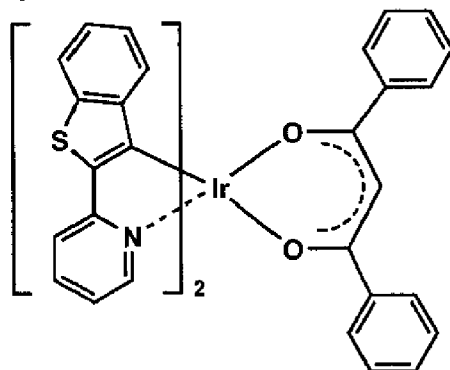
Ir-6



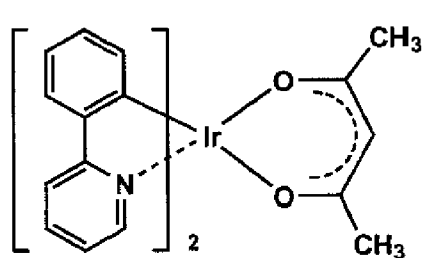
[0138]

[Formula 34]

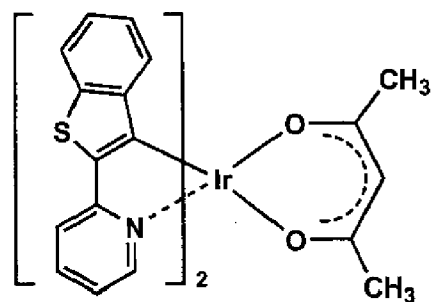
Ir-7



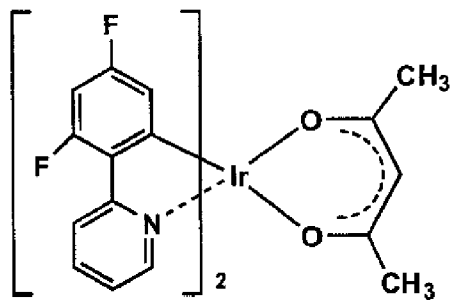
Ir-8



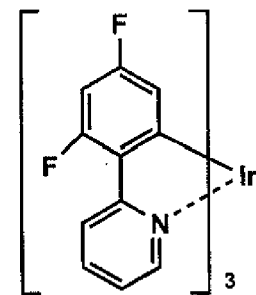
Ir-9



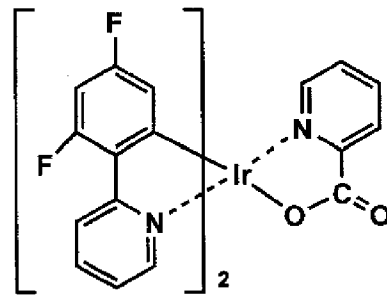
Ir-10



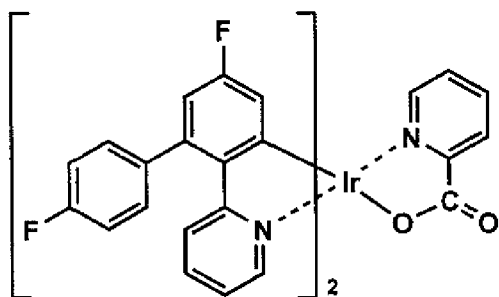
Ir-11



Ir-12



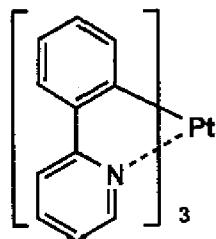
Ir-13



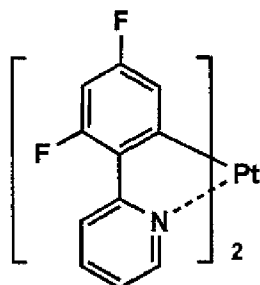
[0139]

[Formula 35]

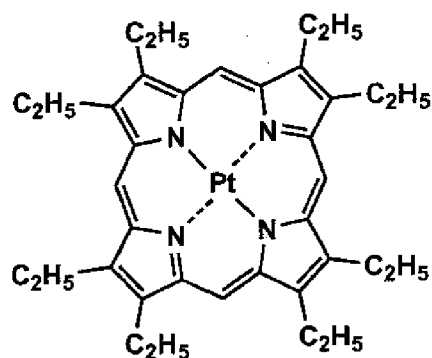
Pt-1



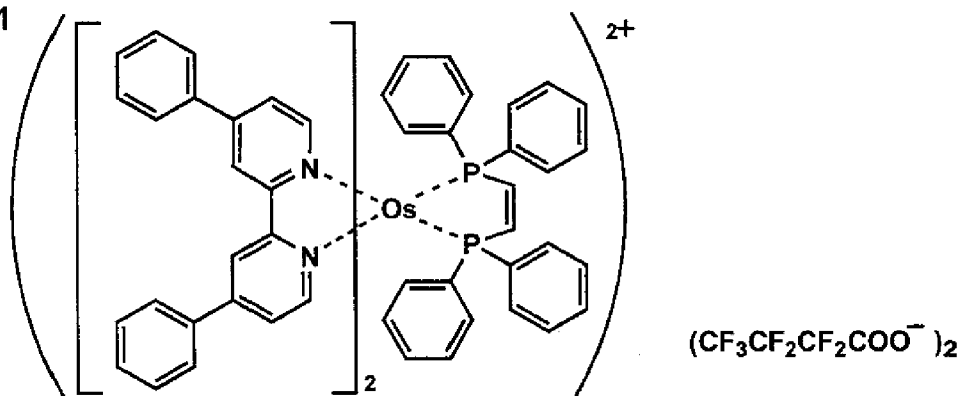
Pt-2



Pt-3



A-1



[0140]

In another gestalt, a fluorescent compound (fluorescence dopant) other than a host compound and a phosphorescent compound may be used. One desirable as a fluorescent compound has a high fluorescence quantum yield at solution states. Here, as for especially a fluorescence

quantum yield, 0.3 or more are [ 0.1 or more ] preferred. Specifically Coumarin series coloring matter, pyran series coloring matter, cyanine dye, crocodile NIUMU system coloring matter, SUKUARIUMU system coloring matter, oxo Benz anthracene system coloring matter, fluorescein system coloring matter, rhodamine dye, pyrylium system coloring matter, a perylene pigment, stilbene series coloring matter, polythiophene system coloring matter, or a rare earth complex system fluorescent substance is mentioned.

[0141]

A fluorescence quantum yield here can also be measured by the method of a 362 pages (1992 editions, Maruzen) statement of the spectrum II of said 4th edition experimental science lecture 7.

[0142]

<<The composition layer of an organic EL device>>

A composition layer of an organic EL device of this invention is explained.

[0143]

In this invention, although a desirable example of lamination of an organic EL device is shown below, this invention is not limited to these.

(1) The anode / multifunctional polymer / negative pole

(2) The anode / hole injection layer / multifunctional polymer / negative pole

(3) The anode / multifunctional polymer / electronic injection layer / negative pole

(4) The anode / hole injection layer / multifunctional polymer / electronic injection layer / negative pole

(5) The anode / multifunctional polymer / hole blocking layer / electronic injection layer / negative pole

(6) The anode / hole injection layer / multifunctional polymer / hole blocking layer / electronic injection layer / negative pole

Functional layers, such as an electron hole transporting bed, an electron transport layer, an electronic device layer, an anode buffer layer, and a cathode buffer layer, may be used if needed besides the above layer. Although what has the few number of layers is more preferred from a field of manufacture of the six above-mentioned kinds of the lamination, there is a tendency for performances, such as luminous efficiency, to be inferior.

[0144]

It is preferred as lamination of this invention to make a hole injection layer and the anode constitute only from multifunctional polymer except it, if a hole injection electrode, and a cathode buffer layer and the negative pole are considered to be electron injection electrodes (above (4)).

[0145]

<<Anode>>

What uses large (not less than 4 eV) metal, an alloy, electrical conductivity compounds, and these mixtures of a work function as electrode material as the anode in an organic EL device is used preferably. As an example of such electrode material, conductive transparent materials, such as metal, such as Au, CuI, indiumtin oxide (ITO),  $\text{SnO}_2$ , and ZnO, are mentioned.

Materials which can produce [ that it is amorphous and ] a transparent conducting film, such as IDIXO ( $\text{In}_2\text{O}_3\text{-ZnO}$ ), may be used. The anode such electrode material by methods, such as vacuum evaporation and sputtering. When a thin film may be made to form, and a pattern of desired shape may be formed with the photolithographic method or you seldom need pattern accuracy, it may form a pattern via a mask of desired shape at the time of vacuum evaporation and sputtering of (about not less than 100 micrometers) and the above-mentioned electrode material. When taking out luminescence from this anode, it is desirable to make transmissivity larger than 10%, and below hundreds of ohms / \*\* of sheet resistance as the anode are preferred. Although thickness is furthermore based also on material, 10-1000 nm is usually preferably chosen in 10-200 nm.

[0146]

<<Negative pole>>

What uses small (4 eV or less) metal (electron injectional metal is called), an alloy, electrical conductivity compounds, and these mixtures of a work function as electrode material as the negative pole is used. As an example of such electrode material, sodium, a sodium potassium alloy, Magnesium, lithium, magnesium / copper mixture, magnesium / silver mixture, Magnesium / aluminum mixture, magnesium / indium mixture, aluminum / aluminum oxide ( $\text{aluminum}_2\text{O}_3$ ) mixture, indium, lithium / aluminum mixture, a rare earth metal, etc. are mentioned. A mixture with the second metal that is a durable point over electron injection nature, oxidation, etc. to electron injectional metal, and metal with it in these, [ a large value of a work function, and ] [ more stable than this ] For example, magnesium / silver mixture, magnesium / aluminum mixture, magnesium / indium mixture, aluminum / aluminum oxide ( $\text{aluminum}_2\text{O}_3$ ) mixture, lithium / aluminum mixture, aluminum, etc. are preferred. The negative pole can produce such electrode material by making a thin film form by methods, such as vacuum evaporation and sputtering. Below hundreds of ohms / \*\* of sheet resistance as the negative pole are preferred, and 10-1000 nm of thickness is usually preferably chosen in 50-200 nm. In order to make luminescent light penetrate, if either one of the anode of an organic EL device or the negative pole is transparent or translucent, light emitting luminance improves and it is convenient.

[0147]

Next, a pouring layer, an electron hole transporting bed, an electron transport layer, etc. which are used as a composition layer of an organic EL device of this invention are explained.



[0148]

<<Pouring layer>>: An electronic injection layer, a hole injection layer

Although a pouring layer is used in order to mainly improve luminous efficiency and a life, and it is not indispensable, since a secondary effect of easing unevenness of the anode or improving with a film of multifunctional polymer of this invention is also acquired especially, it is preferred to use it in this invention. As composition, it is preferred like the above to use it for a layer which touches the anode and the negative pole. The below-mentioned cathode buffer layer is also contained in an electronic injection layer, and an anode buffer layer is also contained in a hole injection layer.

[0149]

It is indicated in detail in the 2nd piece "organic EL device and its industrialization front line (November 30, 1998 N tea S company issue)" and Chapter 2 "electrode material" (123-166 pages), and, specifically, there are a hole injection layer (anode buffer layer) and an electronic injection layer (cathode buffer layer).

[0150]

An anode buffer layer (hole injection layer) is indicated in JP,9-45479,A, a 9-260062 gazette, a 8-288069 gazette, etc., and the details as an example, A phthalocyanine buffer layer represented by copper phthalocyanine, an oxide buffer layer represented by vanadium oxide, Conductive polymers, such as an amorphous carbon buffer layer, poly aniline (EMERARU DIN), and a polythiophene, For example, a polymers buffer layer using (Poly(3, 4) ethylenedioxythiophen-polystyrenesulphona te (PEDOT/PSS)), etc. are mentioned.

[0151]

A cathode buffer layer (electronic injection layer) JP,6-325871,A, The details are indicated in a 9-17574 gazette, a 10-74586 gazette, etc., A metal buffer layer specifically represented by strontium, aluminum, etc., An alkali-metal-compound buffer layer represented by lithium fluoride, an alkaline earth metal compound buffer layer represented by magnesium fluoride, an oxide buffer layer represented by aluminum oxide, etc. are mentioned.

[0152]

As for the above-mentioned buffer layer (pouring layer), it is desirable that it is a very thin film, and although based also on a raw material, the thickness has the preferred range of 0.1-100 nm.

[0153]

With an electrode interface reforming layer said by this invention, a thing of the above-mentioned anode buffer layer and a cathode buffer layer is put.

[0154]

A blocking layer is provided like the above if needed besides a basic constitution layer of an organic compound film. For example, there is an electron hole inhibition (hole block) layer

indicated to 237 pages of JP,11-204258,A, 11-204359, and "an organic EL device and its industrialization front line (November 30, 1998 N tea S company issue)", etc.

[0155]

Recombination probability of an electron and an electron hole can be raised by preventing an electron hole, a hole blocking layer being an electron transport layer in a large meaning, and consisting of material with it, having the function to convey an electron, and conveying an electron. [ remarkable capability to convey an electron hole, and ] [ small ]

[0156]

Recombination probability of an electron and an electron hole can be raised by preventing an electron, an electronic blocking layer being an electron hole transporting bed in a large meaning, and consisting of material with it on the other hand, having the function to convey an electron hole, and conveying an electron hole. [ remarkable capability to convey an electron, and ] [ small ]

[0157]

It becomes an electron hole transporting bed from material which has the function to convey an electron hole, and a hole injection layer and an electronic blocking layer are also contained in an electron hole transporting bed in a large meaning.

[0158]

an electron hole transporting bed and an electron transport layer -- a monolayer -- or two or more layers can be provided.

In an organic EL device of this invention, it is preferred that a fluorescence maximum wavelength of material of a host of a luminous layer, an electron hole transporting bed which adjoins a luminous layer, and all electron transport layers that adjoin a luminous layer is 415 nm or less.

[0159]

<<Luminous layer>>

A luminous layer may be a layer in which an electron and an electron hole which are poured in from an electrode or an electron transport layer, and an electron hole transporting bed recombine and emit light, and a portion which emits light may be in a layer of a luminous layer, or may be an interface of a luminous layer and an adjacent layer.

[0160]

Fundamentally, to a luminous layer, multifunctional polymer of this invention may use together an electron transport material, a hole transporting material, a luminescence dopant (said phosphorescent compound is included), etc. which use \*\*\*\* describes to the following other than multifunctional polymer. It is preferred to use a luminescence dopant in such materials which may be used together, and when a phosphorescence compound is not contained in particular in multifunctional polymer of this invention, concomitant use of the aforementioned

phosphorescence compound is indispensable. In addition, an organic compound or a complex (luminescence dopant) which shows a fluorescence can also be used together.

[0161]

As a compound which can be used together to a luminous layer of this invention, it can choose suitably from publicly known things used for a luminous layer of an organic EL device, and can use. Such a luminescent material is mainly an organic compound, and a compound of Macromol.Synth., 125 volumes, and a 17-25-page statement, etc. can be used for it according to a desired color tone, for example.

[0162]

This luminous layer can be produced by a thin-film-forming method a spin coat method, the cast method, the LB method, a method of a spray, the ink jet method, the painting method, etc. are publicly known, for example, and can form the above-mentioned compound. Although thickness as a luminous layer does not have restriction in particular, it is usually chosen in 5 nm - 5 micrometers. Multifunctional polymer of this invention and material in which the above-mentioned concomitant use is possible may be one layer systems which consist of one sort or two sorts or more, or this luminous layer may be a laminated structure which consists of two or more layers of the same presentation or a different-species presentation. When a luminous layer is formed with a mixture of a phosphorescence compound of a low molecule [ mode / of an organic EL device of this invention / desirable / polymer / multifunctional ], Or it is a time of being multifunctional polymer which contains said polymerization nature phosphorescence compound as a repeating unit, It is a case where use together a dopant which emits light to a wavelength area which is preferably different from at least one sort of phosphorescence dopants, and a phosphorescence dopant in multifunctional polymer of this invention especially, and a photoluminescence layer is formed white.

[0163]

After this luminous layer melts the above-mentioned luminescent material in a solvent and considers it as a solution with binding materials, such as resin, as indicated to JP,57-51781,A, it can thin-film-ize this with a spin coat method etc., and can form it. Thus, although there is no restriction in particular and it can choose suitably about thickness of a formed luminous layer according to a situation, it is usually the range of 5 nm - 5 micrometers.

[0164]

(Dopant)

Next, a dopant is described.

[0165]

Two sorts of kinds of dopant are mentioned as a principle, recombination of a career happens on a host by whom a career is conveyed, and an excitation state of a host compound generates one, An energy transfer type of obtaining luminescence from a dopant by moving

this energy to a dopant, and another are the carrier trap types that a dopant serves as a carrier trap, recombination of a carrier happens by a dopant combination lifter, and luminescence from a dopant is obtained. It is conditions that energy of an excitation state of a dopant compound is lower than energy of an excitation state of a host compound (multifunctional polymer corresponds to this in this invention) in the case of which.

[0166]

<<Electron hole transporting bed>>

It becomes an electron hole transporting bed from material which has the function to convey an electron hole, and a hole injection layer and an electronic blocking layer are also contained in an electron hole transporting bed in a large meaning. an electron hole transporting bed -- a monolayer -- or two or more layers can be provided.

[0167]

As a hole transporting material, there is no restriction in particular, and arbitrary things can be conventionally chosen and used in photoconductive material out of a publicly known thing used for a hole injection layer of what commonly used as an electric charge pouring transported material of an electron hole, or an EL element, and an electron hole transporting bed.

[0168]

A hole transporting material may have electronic pouring [ or ] of an electron hole, transportation, or barrier nature, and may be any of an organic matter and an inorganic substance. For example, a triazole derivative, an oxadiazole derivative, an imidazole derivative, A poly aryl alkane derivative, a pyrazoline derivative, and a pyrazolone derivative, A phenylenediamine derivative, an arylamine derivative, an amino substitution chalcone derivative, An oxazole derivative, a styryl anthracene derivative, a fluorenone derivative, a hydrazone derivative, a stilbene derivative, a silazane derivative, an aniline system copolymer, conductive polymer oligomer, especially thiophene oligomer, etc. are mentioned.

[0169]

As a hole transporting material, although the above-mentioned thing can be used, it is preferred to use a porphyrin compound, an aromatic tertiary-amine compound and a styryl amine compound, especially an aromatic tertiary-amine compound.

[0170]

As an example of representation of an aromatic tertiary-amine compound and a styryl amine compound, they are N,N,N' and an N'-tetraphenyl-4,4'-diaminophenyl;N,N'-diphenyl-N,N'-screw (3-methylphenyl). - [1,1'-biphenyl] -4,4'-diamine. (TPD) A;2,2-screw. (4-di-p-tolylamino phenyl) Propane; An 1,1-screw. (4-di-p-tolylamino phenyl) Cyclohexane;N,N,N', N'-tetra-p-tolyl 4,4'-diaminobiphenyl;1,1-bis(4-di-p-tolylamino phenyl)-4-phenylcyclohexane; A screw. (4-dimethylamino 2-methylphenyl) Phenylmethane;. A screw. (4-di-p-tolylamino phenyl) Phenylmethane; A N,N'-diphenyl-N,N'-JI (4-methoxyphenyl)-4,4'-diaminobiphenyl;N,N,N' and

N'-tetraphenyl-4,4'-diaminodiphenyl ether;4,4'-screw. (Diphenylamino) KUODORI phenyl;N, N,N-Tori (p-tolyl) amine;4-(di-p-tolylamino)-4' - [4-(di-p-tolylamino) styryl] stilbene; -- 4-N,N-diphenylamino (2-diphenylvinyl) benzene; -- 3-methoxy-4'-N,N-diphenylamino still benzene; -- N-phenylcarbazole. (What has in intramolecular two fused aromatic rings written in a U.S. Pat. No. 5,061,569 specification, for example, a 4,4'-screw) [N-(1-naphthyl)-N-phenylamino] 4, 4', 4''-tris by which biphenyl (NPD) and a triphenylamine unit indicated to JP,4-308688,A were connected with 3 starburst type [N-(3-methylphenyl)-N-phenylamino] A triphenylamine (MTDATA) etc. are mentioned.

[0171]

A polymer material which furthermore introduced such materials into a polymers chain, or used such materials as a main chain of polymers can also be used.

[0172]

Inorganic compounds, such as p type-Si and p type-SiC, can also be used as hole-injection material and a hole transporting material.

[0173]

As for a hole transporting material of an electron hole transporting bed, in this invention, it is preferred to have a fluorescence maximum wavelength in 415 nm or less. That is, a hole transporting material prevents long wavelength-ization of luminescence, having electron hole transportation ability, and its compound which is moreover high Tg is preferred.

[0174]

This electron hole transporting bed can form the above-mentioned hole transporting material, for example by thin-film-izing by publicly known methods, such as a vacuum deposition method, a spin coat method, the cast method, the ink jet method, and the LB method. Although there is no restriction in particular about thickness of an electron hole transporting bed, it is usually about 5-5000 nm. This electron hole transporting bed may be one layer system which consists of one sort of the above-mentioned material, or two sorts or more.

[0175]

However, in this invention, it is more preferred from a manufacture side to use for a luminous layer multifunctional polymer which has the function, and not to use an electron hole transporting bed than providing such an electron hole transporting bed separately.

[0176]

<<Electron transport layer>>

It becomes an electron transport layer from material which has the function to convey an electron, and an electronic injection layer and a hole blocking layer are also contained in an electron transport layer in a large meaning. an electron transport layer -- a monolayer -- or two or more layers can be provided.

[0177]

The following material is known as an electron transport material (it serves as electron hole inhibition material) used for an electron transport layer which adjoins the negative pole side to a luminous layer when considering it as an electron transport layer of a monolayer, and two or more layers conventionally. The electron transport layer should just have the function to transmit an electron poured in from the negative pole to a luminous layer, and arbitrary things can be conventionally chosen and used for it out of a publicly known compound as the material.

[0178]

As an example of material (henceforth an electron transport material) used for this electron transport layer, A nitration fluorene derivative, a diphenyl quinone derivative, a thiopyrandioxide derivative, Heterocyclic tetracarboxylic anhydrides, such as naphthalene perylene, a carbodiimide, a FUREORENIRIDEN methane derivative, anthra quinodimethane and the Antron derivative, an oxadiazole derivative, etc. are mentioned. In the above-mentioned oxadiazole derivative, a thiadiazole derivative which replaced an oxygen atom of an oxadiazole ring by a sulfur atom, and a quinoxaline derivative which has the quinoxaline ring known as an electron withdrawing group can also be used as an electron transport material. A polymer material which furthermore introduced such materials into a polymers chain, or used such materials as a main chain of polymers can also be used.

[0179]

A metal complex (Alq), for example, tris(eight quinolinol) aluminum, of an eight-quinolinol derivative, Tris(5,7-dichloro-eight quinolinol) aluminum, tris(5,7-dibromo-eight quinolinol) aluminum, Tris(2-methyl-eight quinolinol) aluminum, tris(5-methyl-eight quinolinol) aluminum, Metal complexes in which a central metal of these metal complexes replaced In, Mg, Cu, Ca, Sn, Ga, or Pb, such as bis(eight quinolinol)zinc (Znq), can also be used as an electron transport material. In addition, a metal freelancer, metal phthalocyanines, or those ends can use preferably what is replaced with an alkyl group, a sulfonic group, etc. as an electron transport material. A JISUCHIRIRU pyrazine derivative illustrated as a material of a luminous layer can also be used as an electron transport material, and inorganic semiconductors, such as n type-Si and n type-SiC, as well as a hole injection layer and an electron hole transporting bed can be used as an electron transport material.

[0180]

As for a desirable compound used for an electron transport layer, it is preferred to have a fluorescence maximum wavelength in 415 nm or less. That is, a compound used for an electron transport layer prevents long wavelength-ization of luminescence, having electron transportation ability, and its compound which is moreover high Tg is preferred.

[0181]

However, in this invention, it is more preferred from a manufacture side to use for a luminous

layer multifunctional polymer which has the function, and not to use an electron transport layer than providing such an electron transport layer separately.

[0182]

<<Base (it is called a substrate, a substrate, a base material, etc.)>>

There is no limitation in particular in kinds, such as glass and a plastic, and as a base concerning an organic EL device of this invention, if transparent, there will be no restriction in particular, but as a substrate used preferably, glass, quartz, and a light transmittance state resin film can be mentioned. Especially a desirable base is a resin film which can give flexible nature to an organic EL device.

[0183]

As a resin film, for example Polyethylene terephthalate (PET), Polyethylenenaphthalate (PEN), polyether sulphone (PES), A film etc. which consist of polyether imide, a polyether ether ketone, a polyphenylene sulfide, polyarylate, polyimide, polycarbonate (PC), cellulose triacetate (TAC), cellulose acetate propionate (CAP), etc. are mentioned.

[0184]

On the surface of a resin film, it is preferred that a tunic (barrier layer) of an inorganic substance or an organic matter or the both hybrid tunic is formed from a viewpoint of gas barrier, and, as for a barrier layer, it is preferred that it is a multilayer film. A desirable thing as an ingredient of a barrier layer Silicon oxide (silica), silicon nitride, Acid silicon nitride, an aluminum oxide (alumina), alumimium nitride, They are organic high polymers, such as metallic oxides and nitrides, such as acid alumimium nitride, tin oxide, and a zinc oxide, polyacrylate, polystyrene and polyolefine, and parylene, those mixtures (a hybrid and a composite are included), etc.

[0185]

As for external extraction efficiency in a room temperature of luminescence of an organic EL device of this invention, it is preferred that it is 1% or more, and it is not less than 2% more preferably. It is electron number x100 passed to the number of photons / organic EL device which emitted light here to the external extraction quantum efficiency (%) = organic EL device exterior.

[0186]

Hue improvement filters, such as a light filter, etc. may be used together.

Although a multicolor display of this invention consists of an organic EL device which has at least two kinds of different luminescence maximum wavelengths, a suitable example which produces an organic EL device next is explained.

[0187]

<<A manufacturing method of an organic EL device>>

As an example of a manufacturing method of an organic EL device of this invention, a method

of producing an organic EL device which consists of the anode / hole injection layer / luminous layer (multifunctional polymer layer) / an electronic injection layer / the negative pole is explained.

[0188]

1 micrometer or less of thin films which consist of desired electrode material, for example, substance for the anodes, are made to form by methods, such as vacuum evaporation and sputtering, on a suitable base, first, so that it may become 10-200-nm thickness preferably, and the anode is produced. Next, an organic compound film of a hole injection layer which is organic EL device material, and a luminous layer is made to form on this.

[0189]

As the film production method of this organic compound film, although there are a spin coat method, the cast method, the ink jet method, a spray method, the painting method, print processes, etc. like the above, The ink jet method from a point of a homogeneous film being easy to be obtained and being hard to generate a pinhole, print processes, or especially a spin coat method is preferred.

[0190]

According to a kind of material, the hole injection layer can also apply vacuum deposition, when using a low molecular weight compound and an inorganic compound, for example. That is, the different producing-film method for every layer may be applied.

[0191]

When adopting vacuum deposition as film production, the vacuum evaporation condition changes with kinds etc. of compound to be used, but. It is desirable to choose suitably generally in boat cooking temperature [ of 50-450 \*\* ] and degree-of-vacuum  $10^{-6}$  -  $10^{-2}$  Pa, an evaporation rate of 0.01-50nm/second, substrate temperature-50-300 \*\*, and the range of 0.1 nm - 5 micrometers of thickness.

[0192]

A desired organic EL device is obtained by making a thin film which consists of an electronic injection layer and a substance for the negative poles on it form by methods, such as vacuum evaporation and sputtering, after formation of these layers, so that 1 micrometer or less may become the thickness of the range of 50-200 nm preferably, and providing the negative pole. Consideration of production of this organic EL device working under a dry inert gas atmosphere is needed.

[0193]

A multicolor display of this invention is producible by patterning a luminous layer. Although there is no limitation in the method, they are vacuum deposition, the ink jet method, print processes, and a spin coat method preferably. In a case where vacuum deposition and a spin coat method are used, patterning using a shadow mask is preferred.



[0194]

It is also possible to make a production order reverse and to produce it in order of the negative pole, an electronic injection layer, an electron transport layer, a luminous layer, an electron hole transporting bed, a hole injection layer, and the anode.

[0195]

What light is taken out also for from the negative pole side (what is called top emission) is possible by using metal for the negative pole at the anode using a transparent electrode and the very thin negative pole.

[0196]

Thus, luminescence can be observed, if + is impressed for the anode and it impresses about voltage 2-40V for the negative pole as polarity of -, in impressing direct current voltage to an obtained multicolor display. Even if it impresses voltage with reverse polarity, luminescence is not produced at all, without current flowing. In impressing a volts alternating current, it emits light, only when the anode becomes + and the negative pole changes into a state of -. A waveform of exchange to impress may be arbitrary.

[0197]

A multicolor display of this invention can be used as a display device, a display, and various sources of luminescent light. In a display device and a display, a full color display is attained by using blue, red, and three sorts of organic EL devices of green luminescence.

[0198]

As a display device and a display, television, a personal computer, mobile computing devices, AV equipment, a teletext display, an information display automatic in the car, etc. are mentioned. A simple matrix (passive matrix) method, an active matrix system, or whichever may be sufficient as a drive system in a case of using it as a display which reproduces especially a still picture and video, and using it as a display for moving image reproduction.

[0199]

Although a back light for domestic lighting, lighting in the car, a clock, or liquid crystals, a signboard advertisement, a signal, a light source of an optical storage medium, a light source of an electro photography copying machine, a light source of an optical-communications processing machine, a light source of a photosensor, etc. are mentioned as a source of luminescent light, it does not limit to this.

[0200]

It may use as an organic EL device which gave resonator structure to an organic EL device concerning this invention.

[0201]

Although a light source of an optical storage medium, a light source of an electro photography copying machine, a light source of an optical-communications processing machine, a light

source of a photosensor, etc. are mentioned as the purpose of using an organic EL device with such resonator structure, it is not limited to these. It may be used for the above-mentioned use by carrying out laser oscillation.

[0202]

<<Display>>

An organic EL device of this invention may be used as a kind of lamp like an object for lighting, or an exposure light source, and a projection device, a still picture, and video of a type which projects a picture may be used for it as a display (display) of a type which carries out a direct-vision private seal. A simple matrix (passive matrix) method, an active matrix system, or whichever may be sufficient as a drive system in a case of using it as a display for moving image reproduction. Or it is possible to produce a full color display by using two or more sorts of organic EL devices of this invention which has the different luminescent color.

[0203]

[Embodiment of the Invention]

An example of the display which comprises an organic EL device of this invention is explained below based on a drawing.

[0204]

Drawing 1 is a mimetic diagram showing an example of the display which comprises an organic EL device. Display picture information by luminescence of an organic EL device, for example, it is a mimetic diagram of the display of a cellular phone etc.

[0205]

The display 1 consists of the control section B etc. which perform the image scanning of the indicator A based on the indicator A which has two or more pixels, and picture information.

[0206]

It is electrically connected with the indicator A, a scanning signal and an image data signal are sent to two or more pixels of each based on the picture information from the outside, the pixel for every scanning line emits light one by one according to an image data signal with a scanning signal, and the control section B performs an image scanning, and displays picture information on the indicator A.

[0207]

Drawing 2 is a mimetic diagram of the indicator A.

The indicator A has on a substrate a wiring section containing two or more scanning lines 5 and data lines 6 and two or more pixel 3 grades. The main members of the indicator A are explained below.

[0208]

In the figure, the light in which the pixel 3 emitted light shows the case where it is taken out to a white arrow direction (down).

[0209]

The scanning line 5 and two or more data lines 6 of the wiring section consisted of electrical conducting materials, respectively, and the scanning line 5 and the data line 6 intersected perpendicularly in the shape of a lattice, and they are connected to the pixel 3 in the position which intersects perpendicularly (not shown for details).

[0210]

An image data signal will be received from the data line 6, and the pixel 3 will emit light according to the received image data, if a scanning signal is impressed from the scanning line 5. The full color display of the color of luminescence becomes possible by juxtaposing suitably the pixel of a red region, the pixel of a green field, and the pixel of blue areas on the same board.

[0211]

Next, the luminescence process of a pixel is explained.

Drawing 3 is a mimetic diagram of a pixel.

[0212]

The pixel is provided with the organic EL device 10, the switching transistor 11, the drive transistor 12, and the capacitor 13 grade. The organic EL device of red, green, and blue light can be used for two or more pixels as the organic EL device 10, and a full color display can be performed by juxtaposing these on the same board.

[0213]

In drawing 3, an image data signal is impressed to the drain of the switching transistor 11 via the data line 6 from the control section B. And if a scanning signal is impressed to the gate of the switching transistor 11 via the scanning line 5 from the control section B, and the image data signal impressed to the drain will be transmitted to the gate of the capacitor 13 and the drive transistor 12. [ the drive of the switching transistor 11 ]

[0214]

One [ the drive of the drive transistor 12 ] while the capacitor 13 is charged by transfer of an image data signal according to the potential of an image data signal. A drain is connected to the power source line 7, source is connected to the electrode of the organic EL device 10, and, as for the drive transistor 12, current is supplied to the organic EL device 10 from the power source line 7 according to the potential of the image data signal impressed to the gate.

[0215]

If a scanning signal moves to the following scanning line 5 by sequential scanning of the control section B, the drive of the switching transistor 11 turns off. However, since the capacitor 13 holds the potential of the charged image data signal even if the drive of the switching transistor 11 turns off, an ON state is maintained, and luminescence of the organic EL device 10 continues the drive of the drive transistor 12 until impression of the following

scanning signal is performed. When a scanning signal is impressed next by sequential scanning, the drive transistor 12 drives according to the potential of the following image data signal in sync with a scanning signal, and the organic EL device 10 emits light.

[0216]

namely, -- luminescence of the organic EL device 10 provides the switching transistor 11 and the drive transistor 12 which are active elements to the organic EL device 10 of two or more pixels of each -- two or more pixels 3 -- light is emitted in each organic EL device 10. Such a light-emitting method is called the active matrix system.

[0217]

Here, luminescence of two or more gradation depended on the image data signal with two or more gradation potential of a multiple value may be sufficient as luminescence of the organic EL device 10, and one of the predetermined light quantity by the image data signal of a binary and OFF may be convenient for it.

[0218]

Maintenance of the potential of the capacitor 13 may be continued and held to impression of the following scanning signal, and it may be made to discharge, just before the following scanning signal is impressed.

[0219]

In this invention, only when not only the active matrix system mentioned above but a scanning signal is scanned, the luminescence drive of the passive matrix system which makes an organic EL device emit light according to a data signal may be sufficient.

[0220]

Drawing 4 is a mimetic diagram of the display by a passive matrix system. In drawing 4, two or more scanning lines 5 and two or more image data lines 6 counter on both sides of the pixel 3, and are formed in the shape of a lattice.

[0221]

When the scanning signal of the scanning line 5 is impressed by sequential scanning, the pixel 3 linked to the impressed scanning line 5 emits light according to an image data signal.

[0222]

In a passive matrix system, there is no active element in the pixel 3, and reduction of a manufacturing cost can be measured.

[0223]

[Example]

Hereafter, although an example explains this invention, the embodiment of this invention is not limited to these.

[0224]

Example 1

## &lt;Production of an organic EL device&gt;

Organic EL device OLED1-1 was produced as follows.

[0225]

After patterning after the substrate (NA-45 by a NH techno glass company) which formed 100 nm of ITO(s) (indiumtin oxide) on the 100mmx100mmx1.1mm glass substrate as the anode, The transparent supporting board which provided this ITO transparent electrode was cleaned ultrasonically with isopropyl alcohol, it dried with dry nitrogen gas, and UV ozone wash was performed for 5 minutes. On this transparent supporting board, it is 30 mg of polyvinyl carbazoles (PVK), and Ir-12. 1.8 mg was dissolved in 1 ml of dichlorobenzene, and under 1000 rpm and the condition of 5 sec, the spin coat was carried out (about 100 nm of thickness), vacuum drying was carried out at 60 degrees for 1 hour, and it was considered as the luminous layer. This was attached to the vacuum evaporator, it ranked second, the vacuum chamber was decompressed to  $4 \times 10^{-4}$  Pa, aluminum 110nm was vapor-deposited as 0.5 nm of lithium fluoride, and the negative pole as a cathode buffer layer, and the negative pole was formed. Glass closure was carried out to the last and organic EL device OLED1-1 was produced.

[0226]

Next, organic EL device OLED1-2 - 1-14 was produced like organic EL device OLED1-1 using the material shown in Table 9 instead of the polymer PVK as a polymeric material.

[0227]

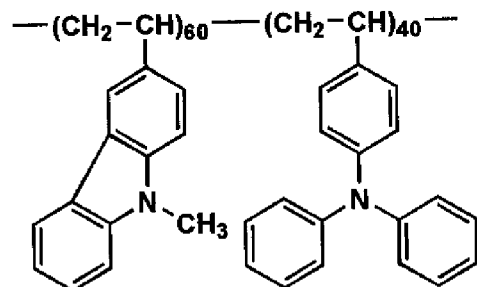
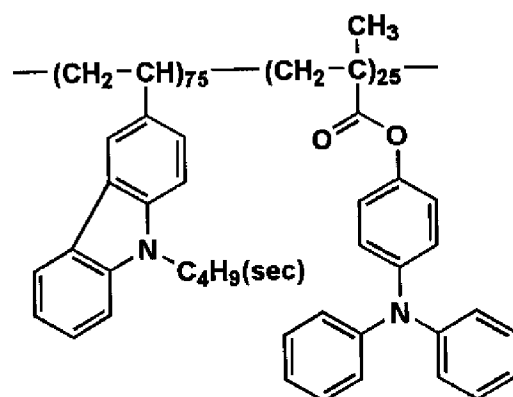
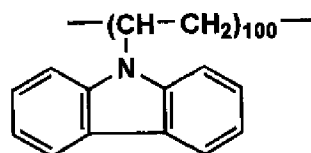
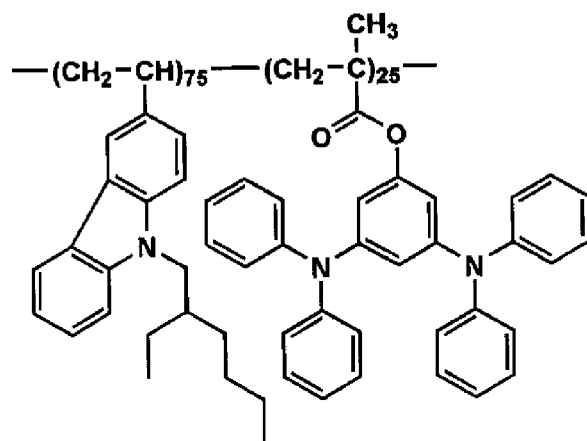
the organic EL device which used Ir-1 and Ir-6 instead of the dopant (Ir-12) currently used for OLED1-7 -- OLED1-7-2 and OLED1-7-3 were produced, respectively.

[0228]

The structure of the compound used above is shown below.

[0229]

[Formula 36]

**R-1****Mw=23000****R-2****Mw=21000****PVK****Mw=12000****R-3****Mw=17000**

[0230]

&lt;Evaluation of an organic EL device&gt;

Organic EL device OLED1-1 produced by performing it as follows - OLED1-14 was evaluated.

The result is shown in Table 9.

[0231]

(Light emitting luminance, luminous efficiency)

The luminescent color of organic EL device OLED1-1 - OLED1-14 was blue. Current began to flow through organic EL device OLED1-1 with the initial drive voltage 7V. Light emitting luminance ( $\text{cd/m}^2$ ) when 12V direct current voltage is impressed under the temperature of 23 \*\* of organic EL device OLED1-1 - OLED1-14 and a dry nitrogen gas atmosphere, and luminous efficiency ( $\text{lm/W}$ ) were measured.

[0232]

Light emitting luminance and luminous efficiency were expressed with the relative value when organic EL device OLED1-1 was set to 100. About light emitting luminance, it measured using CS-1000 (made by Minolta).

[0233]

OLED1-7-2 and OLED1-7-3 showed green and red luminescence, when current was sent respectively.

[0234]

( Endurance)

the time (reduction-by-half lifetime) taken for initial luminance to fall to the original half when it drives by the constant current of  $10 \text{ mA/cm}^2$  -- as a durable index -- a table -- the bottom. The reduction-by-half lifetime was expressed with the relative value when organic EL device OLED1-1 was set to 100.

[0235]

[Table 9]

有機EL素子	ポリマー	ドーパント	発光輝度	発光効率	半減時間	備考
OLED1-1	PVK	Ir-12	100	100	100	比較
OLED1-2	R-1	Ir-12	115	120	115	比較
OLED1-3	R-2	Ir-12	122	115	105	比較
OLED1-4	R-3	Ir-12	108	114	100	比較
OLED1-5	1-1	Ir-12	145	151	205	本発明
OLED1-6	1-9	Ir-12	146	149	200	本発明
OLED1-7	1-12	Ir-12	162	160	235	本発明
OLED1-8	3-2	Ir-12	242	230	380	本発明
OLED1-9	3-12	Ir-12	222	230	365	本発明
OLED1-10	4-5	Ir-12	178	166	240	本発明
OLED1-11	6-2	Ir-12	274	240	380	本発明
OLED1-12	7-3	Ir-12	170	161	240	本発明
OLED1-13	8-1	Ir-12	185	180	305	本発明
OLED1-14	9-3	Ir-12	310	284	385	本発明

[0236]

Light emitting luminance and luminous efficiency have been improved and the organic electroluminescence child of this invention found that it was dramatically useful from endurance being good so that clearly from Table 9.

[0237]

Example 2

&lt;Production of an organic EL device&gt;

Organic EL device OLED2-1 was produced as follows.

[0238]

Like Example 1, it produced the film, washed and dried and the ozone wash of the ITO board (above) was carried out. Vacuum stoving was carried out after carrying out the spin coat of the PEDOT/PSS solution (polyethylene dioxythiophene polysulfone acid dope object; baytron made from a Beyer) by about 100 nm of thickness on this transparent supporting board. Besides, Ir-1 as polymer PVK 30mg and a dopant 1.5 mg, 2 mg of 2-(4-biphenyl)-6-(4-t-butylphenyl) 1,3,4-oxadiazole (OXD) was dissolved in 2 ml of dichloromethane as an electron transport material, and the luminous layer of 100 nm of thickness was obtained by carrying out the spin coat of the solution. This was attached to the vacuum evaporator, it ranked second,



the vacuum chamber was decompressed to  $4 \times 10^{-4}$  Pa, aluminum 110 nm was vapor-deposited as 0.5 nm of lithium fluoride, and the negative pole as a cathode buffer layer, and the negative pole was formed. Glass closure was carried out to the last and organic EL device OLED2-1 was produced.

[0239]

Organic EL device OLED2-2 - 2-13 was produced like organic EL device OLED2-1 using the material shown in Table 10 instead of the polymer PVK as a polymeric material.

[0240]

<Evaluation of an organic EL device>

Evaluation of organic EL device OLED2-1 produced by performing it as follows - 2-13 is performed as follows, and the result is shown in Table 10.

[0241]

(Light emitting luminance, luminous efficiency)

The luminescent color of organic EL device OLED2-1 - OLED2-13 was green. Current began to flow through organic EL device OLED2-1 with the initial drive voltage 5V. Light emitting luminance ( $\text{cd/m}^2$ ) when 10V direct current voltage is impressed under the temperature of 23 \*\* of organic EL device OLED2-1 - 2-13 and a dry nitrogen gas atmosphere, and luminous efficiency ( $\text{lm/W}$ ) were measured.

[0242]

Light emitting luminance and luminous efficiency were expressed with the relative value when organic EL device OLED2-1 was set to 100. About light emitting luminance, it measured using CS-1000 (made by Minolta).

(Endurance)

the reduction-by-half lifetime which is the time taken for initial luminance to fall to the original half when it drives by the constant current of  $10 \text{ mA/cm}^2$  -- as a durable index -- a table -- the bottom. The reduction-by-half lifetime was expressed with the relative value when organic EL device OLED2-1 was set to 100.

[0243]

[Table 10]

有機EL素子	正孔注入材料	ポリマー	ドーパント	電子輸送材料	発光輝度	発光効率	半減時間	備考
OLED2-1	PEDOT	PVK	Ir-1	OXD	100	100	100	比較
OLED2-2	PEDOT	R-1	Ir-1	OXD	111	113	115	比較
OLED2-3	PEDOT	R-2	Ir-1	OXD	100	110	120	比較
OLED2-4	PEDOT	R-3	Ir-1	OXD	109	111	105	比較
OLED2-5	PEDOT	2-14	Ir-1	—	176	168	275	本発明
OLED2-6	PEDOT	3-8	Ir-1	—	238	235	310	本発明
OLED2-7	PEDOT	3-13	Ir-1	—	210	208	285	本発明
OLED2-8	PEDOT	4-8	Ir-1	—	140	138	200	本発明
OLED2-9	PEDOT	5-2	Ir-1	—	168	170	255	本発明
OLED2-10	PEDOT	6-3	Ir-1	—	246	238	325	本発明
OLED2-11	PEDOT	7-5	Ir-1	—	160	164	180	本発明
OLED2-12	PEDOT	8-7	Ir-1	—	208	204	275	本発明
OLED2-13	PEDOT	9-5	Ir-1	—	275	264	340	本発明

[0244]

Light emitting luminance and luminous efficiency have been improved compared with the comparison organic EL device which added the low-molecular electron transport material separately, and the fact that endurance was good showed that the organic EL device of the composition of this invention was dramatically useful so that clearly from Table 10.

[0245]

Example 3

Organic EL device OLED3-1 was produced as follows.

[0246]

Dopant of OLED2-1 produced in Example 2 Ir-1 They are 1.5 mg Ir-12 2.0 mg and Ir-6 Organic EL device OLED3-1 was produced by the completely same method as OLED2-1 except having transposed to 0.2 mg. Furthermore, the polymer PVK of organic EL device OLED3-1 was changed to the polymer shown in the following table 11, and organic EL device OLED3-2 - 3-19 was produced.

[0247]

The relative comparison was performed on the basis of OLED3-1 by the same technique as

Example 2. The luminescent color was luminescence in which every element is almost white. The result is shown in Table 11.

[0248]

[Table 11]

有機EL素子	正孔注入材料	ポリマー	ドーパント	電子輸送材料	発光輝度	発光効率	半減時間	備考
OLED3-1	PEDOT	PVK	Ir-12/Ir-6	OXD	100	100	100	比較
OLED3-2	PEDOT	R-1	Ir-12/Ir-6	OXD	111	113	115	比較
OLED3-3	PEDOT	R-2	Ir-12/Ir-6	OXD	100	110	120	比較
OLED3-4	PEDOT	R-3	Ir-12/Ir-6	OXD	109	111	105	比較
OLED3-5	PEDOT	1-7	Ir-12/Ir-6	—	115	116	135	本発明
OLED3-6	PEDOT	1-10	Ir-12/Ir-6	—	108	104	140	本発明
OLED3-7	PEDOT	1-12	Ir-12/Ir-6	—	109	110	150	本発明
OLED3-8	PEDOT	2-16	Ir-12/Ir-6	—	221	208	235	本発明
OLED3-9	PEDOT	3-10	Ir-12/Ir-6	—	225	225	280	本発明
OLED3-10	PEDOT	3-14	Ir-12/Ir-6	—	222	220	260	本発明
OLED3-11	PEDOT	4-7	Ir-12/Ir-6	—	125	139	190	本発明
OLED3-12	PEDOT	6-5	Ir-12/Ir-6	—	242	251	305	本発明
OLED3-13	PEDOT	5-9	Ir-12/Ir-6	—	205	198	235	本発明
OLED3-14	PEDOT	7-5	Ir-12/Ir-6	—	198	201	220	本発明
OLED3-15	PEDOT	7-4	Ir-12/Ir-6	—	102	107	170	本発明
OLED3-16	PEDOT	8-4	Ir-12/Ir-6	—	106	112	190	本発明
OLED3-17	PEDOT	8-6	Ir-12/Ir-6	—	226	218	195	本発明
OLED3-18	PEDOT	9-6	Ir-12/Ir-6	—	312	305	330	本発明
OLED3-19	PEDOT	10-2	—	—	304	301	380	本発明

[0249]

#### Example 4

The active matrix system full color display which was produced in Example 1 and which juxtaposes red, green, and a blue light organic EL device on the same board, respectively, and is shown in drawing 1 was produced. Only the mimetic diagram of the indicator A of the produced full color display was shown in drawing 1. Namely, the wiring section which contains two or more scanning lines 5 and data lines 6 on the same board, It had two or more juxtaposed pixels 3 (the colors of luminescence are a pixel of a red region, a pixel of a green field, a pixel of blue areas, etc.), and the scanning line 5 and two or more data lines 6 of the wiring section consisted of electrical conducting materials, respectively, and the scanning line 5 and the data line 6 intersected perpendicularly in the shape of a lattice, and it has connected

with the pixel 3 in the position which intersects perpendicularly (not shown for details). Said two or more pixels 3 are driven with the active matrix system with which the switching transistor which are an organic EL device corresponding to each luminescent color and an active element, and each drive transistor were provided.

If a scanning signal is impressed from the scanning line 5, an image data signal will be received from the data line 6, and light will be emitted according to the received image data. Thus, a full color display becomes possible by juxtaposing each red and a green and blue pixel suitably.

[0250]

By driving a full color display, the clear full color animation display with good endurance with high luminosity was obtained.

[0251]

Example 5

The nonluminescent side of organic EL device OLED3-18 of Example 3 was covered with the glasscase, and it was considered as the lighting system. By using DC power supply, the lighting system was able to be used as a thin lighting system which emits white light. Drawing 5 is a schematic diagram of a lighting system, and drawing 6 is a sectional view of a lighting system.

[0252]

[Effect of the Invention]

By this invention, luminous efficiency is high and an organic electroluminescence element by which manufacture load was reduced and a manufacturing method for the same, the display which has it, a lighting system, and a light source can be provided.

[Brief Description of the Drawings]

[Drawing 1] It is a mimetic diagram showing an example of the display which comprises an organic EL device.

[Drawing 2] It is a mimetic diagram of an indicator.

[Drawing 3] It is a mimetic diagram of a pixel.

[Drawing 4] It is a mimetic diagram of a passive-matrix method full color display.

[Drawing 5] It is a schematic diagram of a lighting system.

[Drawing 6] It is a sectional view of a lighting system.

[Description of Notations]

1 Display

3 Pixel

5 Scanning line

6 Data line

7 Power source line

10, 101 organic EL devices  
11 Switching transistor  
12 Drive transistor  
13 Capacitor  
102 Glass cover  
103 Power source wire (anode)  
104 Power source wire (negative pole)  
105 Negative pole  
106 Organic electroluminescence layer  
107 ITO (transparent electrode)  
108 Glass substrate  
109 Nitrogen gas  
110 Drier (barium oxide)  
A Indicator  
B Control section

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[Translation done.]